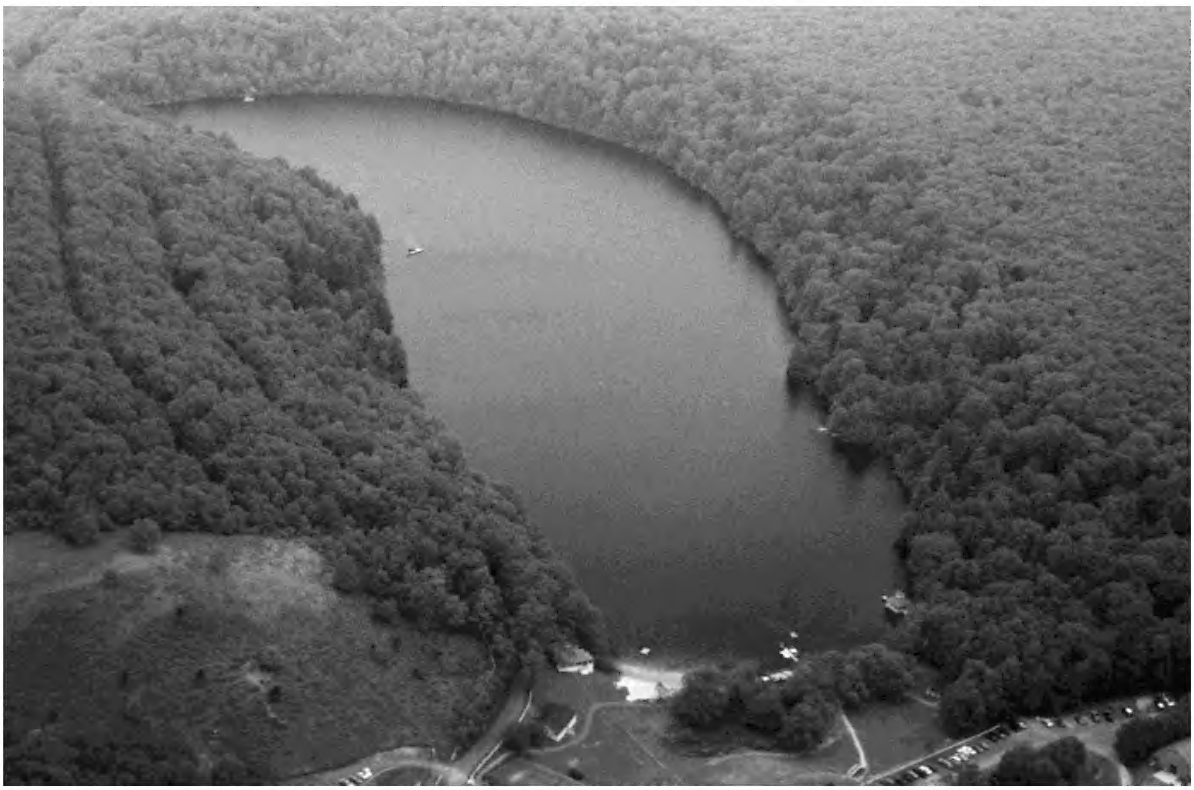
BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA



More than a century of research studies on the limnology, geology, origin, and paleohistory of Mountain Lake, Giles County, one of only two natural lakes in Virginia, is reviewed in the lead article of this issue.

Number 22 ISSN 1066-0712 2003

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ISSN 1066-0712

Published by the Virginia Natural History Society

The Virginia Natural History Society (VNHS) is a nonprofit organization dedicated to the dissemination of scientific information on all aspects of natural history in the Commonwealth of Virginia. Membership in VNHS includes a subscription to *Banisteria*. Annual dues are $20.00 (per calendar year); library subscriptions to *Banisteria* are $40.00. Subscribers/members outside the United States should add $3.00 for additional postage. Checks should be made payable to the Virginia Natural History Society. Membership dues and inquires should be directed to the Secretary-Treasurer (address, page 2); correspondence regarding *Banisteria* to one of the co-editors. *Banisteria* is a peer-reviewed journal. For additional information regarding the VNHS, including other membership categories and instructions for prospective authors of *Banisteria* papers, consult our website at: **http://fwie.fw.vt.edu/vnhs/**

Banisteria No. 21 was published on 23 June 2003.

Cover: Aerial view of Mountain Lake, Giles County, Virginia; photo by Bruce Parker, August 1985.
Inner back cover: Original drawing by John Banister; provided by Joseph and Nesta Ewan.

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Number 22, 2003

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Banisteria, Number 22, 2003

A Review of Research Studies at Mountain Lake, Virginia

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INTRODUCTION

Mountain Lake, Giles County, Virginia (37° 27' 56" N, 80° 31' 39" W) is the only natural lake of significance in the unglaciated highlands of the southern Appalachians (Fig. 1). This oligotrophic montane lake located at 1181m (3875 ft) elevation near the summit of Salt Pond Mountain occupies a relatively small, undisturbed watershed which is about five times the surface area of the full lake. All surface outflow of water occurs at the northwest end into Pond Drain, then Little Stony Creek and the New River. Although Mountain Lake (or Salt Pond) has been known since its discovery by the British surveyor Christopher Gist in 1751 (Johnston, 1898), it remained free of published scientific studies until 1884. This first and many subsequent scientific studies of Mountain Lake are scattered widely among various journals, books, documents, and theses (often unpublished or obscure), making acquisition and compilation difficult. Yet this literature is relevant and often essential for future investigations, especially in the physical, chemical, and biological limnology, the geology, and the origin and paleohistory of Mountain Lake. Accordingly, a brief chronological review of the pertinent scientific literature on Mountain Lake with some previously unpublished new information from the author's laboratory and field records are here included.

LITERATURE REVIEW

Rogers' (1884) geological studies of the Virginias comprises the first scientific work on Mountain Lake, published posthumously. Rogers investigated the geology around the lake during his appointment as Director of the Geological Survey of Virginia (today's Virginia and West Virginia) in 1835-1841. The following excerpts beginning on page 109 are especially informative:

> *One of the most curious objects in the particular district which we have just been treating, is the lake near the summit of Salt Pond Mountain ... This beautiful sheet of water is situated at the intersection of the Salt Pond Mountain and several of its spurs, and not as is commonly supposed, on the top of the mountain. Its height above the base of the mountain, is probably from 900 to 1000 feet, but it is surrounded by steep and lofty hills on every side, excepting that by which it is approached, and that through which its water finds a small outlet, falling in a picturesque cascade of great height, and then flowing rapidly into the creek below. The outlet appears formerly to have been deeper than at present, and the extent of the lake was therefore much less than it now is. Rocks and earth gradually accumulating at the passage, have dammed the waters up, and hence the trees and shrubs which grew upon its margin, may now be seen sometimes standing erect at a considerable depth beneath its surface. Its length is about three quarters of a mile–its greatest width about half a mile. By careful soundings from side to side, in many parts of it, the greatest depth that could be found was from 56 to 60 feet; but such was the transparency of the water, that the bottom could be seen nearly in its deepest parts. No animal is found in it but a small species of salamander or water lizard*. [W. B. Rogers, Director, Geological Survey of Virginia, 1835-41; President, National Academy of Sciences]

Rogers (1884) made several points noteworthy when compared to Mountain Lake today. The "cascade of great height" entering Pond Drain no longer exists; it may have been eliminated when the county road was built along the west side of the lake. Second, the "trees and shrubs" seen "at considerable depth" attest to the dramatic fluctuations in lake levels. These have been documented in Table 1. The lake must have been full in 1835-41 to have a cascade and submerged trees at considerable depth. Rogers' maximum depth measurement of 60 feet shows that he failed to detect the deepest point shown in Fig. 1.

The second scientific study of Mountain Lake was nearly a century later. Williams (1930) conducted the first limnological investigation during the first summer of classes at the University of Virginia's Mountain Lake Biological Station. The lake measured 0.75 mi (1.2 km) long, 0.25 mi (0.40 km) wide, and 110 ft (33.5 m) maximum depth. This was the first report of the great maximum depth, which was only positively verified 69

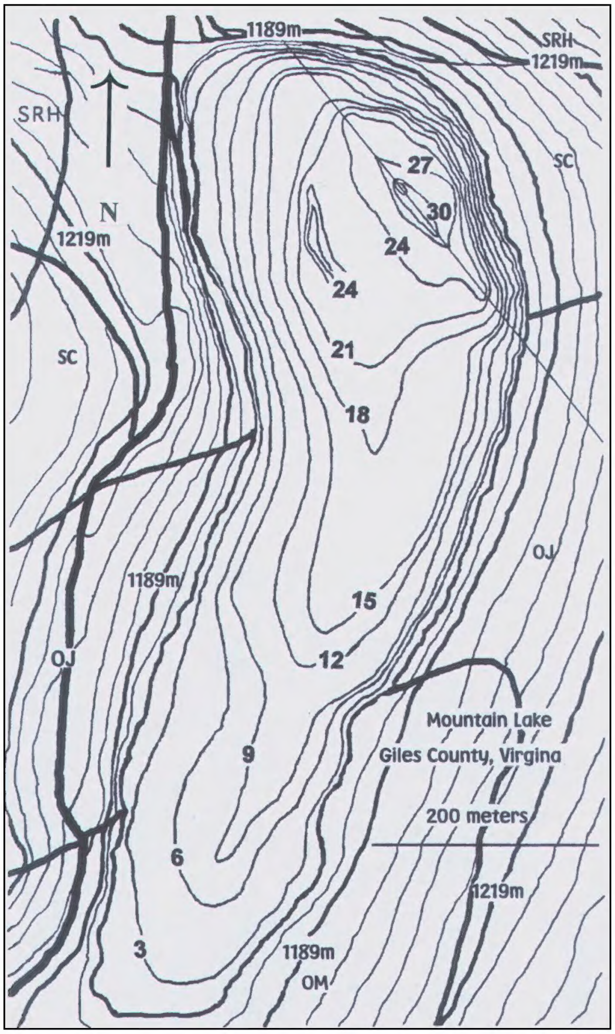

Fig. 1. Sonar bathymetric map of Mountain Lake in 1997 showing the SE to NW fracture trace. Lake depth contours and surrounding USGS topographic contours in meters. OM = Ordovician Martinsburg shale, OJ = Ordovician Juniata sandstone, SC = Silurian Clinch sandstone, SRH = Silurian Rose Hill sandstone.

years later when the first sonar mapping of the lake bathymetry was reported (Cawley, 1999; Cawley et al., 2001b). Surface water temperatures in July-August 1930 were 23.5-24.5 ^{o}C. Williams noted that the lake was fed mostly by springs rather than surface input. Chemically the lake water was characterized by pH 6.4, 30 mg/l bicarbonate, 1.4 mg/l dissolved silica, and no detectable nitrate. Several other variables measured at VPI's Chemistry Department laboratories and reported by Williams may not have been reliable by the analytical methods available in 1930, which moreover were not cited in the thesis. Plankton tows collected 15 green algae and two diatoms (Table 2). Williams also identified one protozoan, one rotifer, and three crustaceans as part of the zooplankton (Table 3).

Hutchinson & Pickford (1932) made two brief visits to Mountain Lake in the summer of 1931, primarily to explore the limnology and origin of the lake. Physical and chemical variables cited were Secchi disk transparency depth (7.0 m), dissolved oxygen (8.0 mg/l at 22 m), soluble phosphate phosphorus (0-3 µg/l at 10 m), nitrate nitrogen (0-20 µg/l at 10 m), and dissolved silica (1.0-2.8 mg/l at 10m). Magnesium, calcium, sulfate, chloride, iron, and several other chemicals also were measured. The net plankton consisted of one blue-green alga, 11 green algae, one diatom, two rotifers, and three cladocerans (Tables 2, 3). Hutchinson & Pickford (1932) also addressed the origin of Mountain Lake primarily by quoting a Mr. G.A. Stone:

> *...a stream flowed north and cut a rocky gap in the Clinch sandstone, which overlies the Martinsburg shale.* [Note that the Juniata sandstone which lies between the Clinch and Martinsburg was either overlooked or assumed to be part of the Clinch Formation.] *The lake was formed by the caving in of overhanging ledges of this hard rock undermined by the stream, large fallen masses clogging the narrow outlet and damming up the stream.*

Sharp (1933) published the first detailed geological study at Mountain Lake and discussed the lake's origin, building upon the earlier work of Rogers (1884) and Hutchinson & Pickford (1932). Sharp states:

> *The valley of a stream flowing through one of these ridges was apparently dammed by blocks creeping downward from the ridge, thus impounding the lake...*

and

> *...great blocks of the* [Clinch] *formation crept downward over the shale slopes, gradually filling the valley bottom just above the notch. The Clinch may also have fallen as talus, or as a rockslide, although there is no evidence of the latter.*

and later

> *Stumps rooted one or two feet below the surface of the lake indicate a fairly recent increase in depth. ...maybe attributed to a more thorough sealing of the interstices of the block dam.*

Once again, the Juniata sandstone lying between the Clinch and Martinsburg was not mentioned.

Ferguson et al. (1939) surveyed the turbellarian fauna in the Mountain Lake region during summer 1938. From the lake they reported 19 species (Table 3). This paper also reports chemical analytical data, such as iron, aluminum oxides, bicarbonates, dissolved silica, calcium, magnesium, nitrates, and dissolved oxygen–all very similar to the data of Hutchinson & Pickford (1932). In

addressing the lake's origin, the geological formation description again did not mention the Juniata sandstone. Moreover, Ferguson et al. attributed the lake's origin to "a natural solution collapse basin", proposed earlier by Holden (1938), and claimed that the Martinsburg shale underlying the basin was high in lime content, a point never confirmed by any other investigators (Parker et al., 1975).

Coker & Hayes (1940) during the 1937 summer led their hydrobiology class at the biological station in a study of the biota of Mountain Lake. Using plankton net tows, they found one blue-green, one diatom, one chrysophyte, one coccoid dinoflagellate, six green algae, one protozoan, one copepod, two cladocerans, and two rotifers (Tables 2, 3). Macrophytes collected from the lake included *Elodea, Isoetes, Alisma plantago-aquatica, Eleocharis obtusa*, and an unidentified grass. Secchi disk transparency was 5.5 m. Grover & Coker (1940) added a few other algal taxa (Table 2), as well as counts at different depths for select plankton, based on the same 1937 summer collections while at the biological station. Forest's (1954) checklist of algae in the vicinity of Mountain Lake Biological Station also included a number of species from the lake (Table 2).

McCalla (1942) examined the year-round numbers and distribution of Crustacea in Mountain Lake, 1941-42. His thesis addressed especially the copepod *Diaptomus leptopus* Forbes and the cladocerans *Daphnia pulex* deGeer, *Diaphanosoma brachyurum* Lievin, and *Bosmina obtusirostris* Sars. McCalla also listed a few net phytoplankton and zooplankton, and the deep water midge *Chaoborus* Lichtenstein (Tables 2, 3).

Table 1. Approximate percent of a full Mountain Lake based on 24 historical accounts (see below). Updated since Parker et al. (1975).

YEAR(S)	% of FULL LAKE	SOURCE	YEAR(S)	% of FULL LAKE	SOURCE
1751	80	A	1898-1904	60, 100	L
1768-1804	20	B	1904-05	100	M
1794	50	C	1913	95	J
1820	50	D	1930	95	J
1835	100	E	1935	85	N
1855	100	F	1952-53	85	O
1861	100	G	1959 spring	60	P
1864	100	H	1959 summer	100	P
1865-1869	20	I	1969-97	100	Q
1871	100	G	1997-2000	95	Q
1879	100	J	2001-02	75	R
1885-88	95	K	2003 summer	100	R

Sources: A = Gist 1751, according to Pownall (1776), Darlington (1893), Johnston (1898), Summers (1903), Mulkearn (1954). B = Johnston (1906), Roberts, cited by Lewis (1957). C = Deed to property with sketch (Marland, 1967). D = Lewis (1957). E = Rogers (1884). F = Robert Beyer painting (Wright, 1973). G = Pollard (1870), Pendleton (1920). H = Major Barnett cited by Lewis (1957). I = Mrs. Ingles cited by Lewis (1957). J = Chapman (1949). K = Mrs. Ingles cited by Chapman (1949), Lewis (1957). L = Chapman (1949), Campbell (1898). M = Dietrich (1957). N = Lewis (1957). O = USDA, Soil Conservation Service aerial photograph. P = Mrs. Dolinger, pers. comm. (Parker et al., 1975). Q = Parker and students. R = Parker.

Table 2. Algal taxa reported from Mountain Lake. Classification follows Lee (1999) and Cawley et al. (1999) with taxa listed alphabetically under their classes. Numbers following taxa indicate sources: 1 = Williams (1930), 2 = Hutchinson & Pickford (1932), 3 = Coker & Hayes (1940), 4 = Grover & Coker (1940), 5 = McCalla (1942), 6 = Forest (1954), 7 = Whitford (1964), 8 = Obeng-Asamoa & Parker (1972), 9 = Dubay & Simmons (1979), 10 = Van Brunt (1984), 11 = Jervis (1988), 12 = Parson & Parker (1989b), 13 = Beaty & Parker (1994), 14 = Beaty & Parker (1996a), 15 = Cawley et al. (1999), 16 = Cawley et al. (2001a), 17 = Cawley et al. (2002). Taxa designated [b] are primarily benthic, other taxa are primarily planktonic.

CYANOPROKARYOTA	
CYANOPHYCEAE	
Unknown colonial sp.	2
Anabaena sp.	3, 4, 7, 8, 15
Anacystis sp.	7
Aphanocapsa delicatissima West & West	8
Aphanocapsa elachista West & West	8, 12, 14
Aphanocapsa elachista var. conferta West & West	12
Aphanocapsa endophytica G.M. Smith	8
Aphanocapsa rivularia (Carm.) Rabenhorst	12
Aphanothece sp.	1
Aphanothece gelatinosa (Henn.) Lemmermann	8
Aphanothece microscopica Nageli	7, 8, 12, 15
Aphanothece saxicola Naegeli	12
Aphanothece stagnina (Spreng.) A. Braun	6
Chroococcus dispersus (V. Keiss) Lemmermann	8, 12
Chroococcus dispersus var. *minor* G.M. Smith	7, 15
Chroococcus minimum (Keisal.) Lemmermann	12
Chroococcus minor (Kütz.) Naegeli	8
Chroococcus minutus (Kütz.) Naegeli	12, 14
Chroococcus varius A. Braun in Rabenhorst	12
Coccochloris stagnina Spreng. from *Coelosphaerium* sp.	6
Cylindrospermum catenatum Ralfs	6
Dactylococcopsis musicola Hustedt	12
Eucapsis sp.	12
Gloeocapsa halmatodes Kützing	12, 15
Gloeocapsa punctata Naegeli	8
Gloeocapsa sp.	12
Gomphosphaeria wichurae (Hilse) Drouet & Daily	8
Gomphosphaeria sp.	6
Hapalosiphon arboreus West & West	6
Hapalosiphon pumilus (Kütz.) Kirchner	8
Merismopedia glauca (Ehren.) Naegeli	8
Merismopedia punctata Meyen	8
Merismopedia tenuissima Lemmermann	8
Merismopedia sp.	2, 8
Microcystis aeruginosa Kützing	8, 12
Microcystis firma (Bréb. et Lenom.) Schmidle	12
Microcystis incerta Lemmermann	8
Nostoc spongiaeforme C.A. Agardh	12
Oscillatoria sp.	7, 8, 12, 14
Oscillatoria agardhii Gomont	6
Oscillatoria angustissima West & West	12
Phormidium uncinatum (Agardh) Gomont	6, 12
Phormidium sp.	12
Radiocystis geminata Skuja	12
Rivulalia beccariana (De Not.) Born & Flahault	6
Rivularia compactum (Ag.) Born & Flahault	6
Scytonema mirabile (Dillw.) Born	6, 12
Sacconema sp.	6
CHLOROPHYTA	
CHLOROPHYCEAE	
Ankistrodesmus falcatus (Corda) Ralfs	7, 8, 12
Ankistrodesmus falcatus var. *mirabilis* West & West	12
Aphanochaete vermiculoides Wolle (discussed as *Herposteiron vermicularis*)	1
Botryococcus braunii Kützing	8, 12
Botryococcus protuberans var. *minor* G.M. Smith	8
Botryococcus sudeticus Lemmermann	12
Bulbochaete sp.	6, 8, 12, 14
Carteria sp.	10
Chaltosphaeridium sp.	6
Chlamydomonas cienkowskii Schmidle	8
Chlamydomonas globose Snow	8
Chlamydomonas reinhardi Dangeard	10
Chlamydomonas sp.	1, 7, 10, 12, 15
[b]*Characium cylindricum* Lambert	1
Chlorella vulgaris Beijerinck	8, 12, 15
Chlorococcum sp.	13, 15
Chodatella sp.	13, 15
Coelastrum microsporum Naegeli	12
Crucigenia irregularis Wille	8, 12
Crucigenia quadrata Morren	3, 4, 8, 12, 15
Crucigenia rectangularis (Naeg.) Gay	3, 8, 12
Cylindrocapsa sp.	12
Dictyosphaerium ehrenbergianum Naegeli	8
Dictyosphaerium pulchellum Wood	6, 7, 8, 12
Dictyosphaerium reniforme Bulnhein	6, 7
Dictyosphaeriopsis sp.	3, 4
Dimorphococcus lunatus A. Braun,	3, 4
Elakatothrix gelatinosa Wille	12
Eremosphaera viridis DeBary	4, 6
Eudorina elegans Ehrenberg	7, 15
Gloeoactinum limneticum G.M. Smith	6
Gloeocystis gigas (Kütz.) Lagerheim	8, 12
Gloeocystis maior Gerneck ex Lemmermann	12
Gloeocystis paraliniana (Menegh.) Naegeli	12
Gloeocystis planctonica (West & West) Lemmerman	12,15
Gloeocystis vesiculosa Naegeli	8, 12
Gloeocystis sp.	7
Kirchneriella lunaris (Kirch.) Moebius	8
Kirchneriella obesa (W. West) Schmidle	12
Kirchneriella sp.	2, 6
Lobocystis dichotoma Thompson	12
Microspora stagnorum (Kütz.) Lagerheim	6
Microspora sp.	7
Nephyrocytium agardhianum Naegeli	12
Oedogonium sp.	1, 8, 12, 14
Onychonema filiforme (Ehren.) Roy & Bisset	6
Oocystis borgei Snow	8, 12, 14
Oocystis crassa Wittrock	8
Oocystis elliptica West & West	8
Oocystis eremosphaeria G.M. Smith	12
Oocystis pusilla Hansgirg	12, 15
Oocystis sp.	12
Ourococcus sp.	6
Palmella sp.	6
Pandorina morum (Muell.) Bory	7, 13, 15
Pediastrum araneosum (Racib.) G.M. Smith	8
Pediastrum biradiatum Meyen	12
Pediastrum boryanum (Turp.) Meneghini	8, 15
Pediastrum duplex var. *rugulosum* Raciborski	12
Pediastrum integrum Naegeli	7, 8, 12

Table 2 (continued)

CHLOROPHYCEAE (continued)	
Pediastrum sculptatum G.M. Smith	12
Pediastrum tetras forma *evoluta* West	12
Planktosphaeria gelatinosa G.M. Smith	4, 6, 8
Protoderma viride Kützing	8
Protoderma sp.	6
Quadrigula chodatii (Tan.-Ful.) G.M. Smith	2, 8, 12, 13, 14, 15
Quadrigula closteroides (Bohlin) Printz	12
Quadrigula lacustris (Chod.) G.M. Smith	7, 8
Quadrigula pfitzeyi (Schroder) G.M. Smith	12
Quadrigula sp.	2, 6
Radiofilum conjuctivum Schmidle	8
Rhizoclonium sp.	12
Scenedesmus arcuatus Lemmermann	12
Scenedesmus bijuga (Turp.) Lagerheim	6, 12, 15
Scenedesmus obliquus (Turp.) Kützing	8
Scenedesmus quadricauda (Chod.) G.M. Smith	12
Scenedesmus quadricauda (Turp.) Brébisson var. *quadrispina*	8, 12
Scenedesmus sp.	8
Schoederia setigera (Schroed.) Lemmermann	12
Scourfieldia complanata West	12, 15
Selenastrum sp.	13, 15
Sphaerellopsis gloeocystiformis Dill	12
Sphaerocystis schroeteri Chodat	7, 8, 13, 14
Sphaerocystis sp.	6
Sphaerozoma granulatum Roy & Bissett	7
Stichococcus bacillaris Naegeli	12
[b]*Stigeoclonium flagelliferum* Kützing	12
[b]*Stigeoclonium* sp.	12
Stylosphaeridium stipitatum (Bachm.) Geitler & Gimesi	12
Tetraedron sp.	13, 15
Tetraspora lubrica (Roth) Agardh	1
Tetraspora sp.	12
Trochiscia sp.	13, 15
Volvox aureus Ehrenberg	2, 4, 5, 6, 8, 13, 14
Volvox tertius Meyer	4, 5, 8
Volvox sp.	1
Unknown flagellate sp.	8, 12
ULVOPHYCEAE	
[b]*Ulothrix subconstricta* G.S. West	12
CHAROPHYCEAE	
Arthrodesmus incus (Bréb.) Hassall	6
Arthrodesmus octocornis Ehrenberg	6
Arthrodesmus phimus Turner	12
Arthrodesmus quadratus (Schm.) Teiling	12, 15
Arthrodesmus subulatus Kützing	12
Arthrodesmus sp.	7
Bambusina brebissonii Kützing	8, 12
Bambusina confervacea West & West	12
Chaetosphaeridium spp.	6
[b]*Chara braunii* Gemlin	9
[b]*Chara schweinitzii* A. Braun	7
[b]*Chara* sp.	3, 11
Closterium baillyanum Brébisson	12
Closterium costatum Corda	12
Closterium lunula forma *gracilis* Messik	8
Closterium nematodes Josh	12
Closterium moniliferum (Bréb.) Ehrenberg	8, 12
Closterium sigmoideum (Lagerh.) Norstedt	8
Closterium sp.	1, 2, 7, 8
Cosmarium botrytis Meneghini	7, 8
Cosmarium commensurale Nordst	8
Cosmarium contractum var. *papillatum* West & West	2
Cosmarium dentatum Wolle	4, 8, 12
Cosmarium denticulatum Borge	7, 12
Cosmarium denticulatum forma *borgei* Irene-Marie	8
Cosmarium furcatospermum West & West	6
Cosmarium margaritatum (Lund.) Roy & Bisset	8
Cosmarium monomazum Lundell	8
Cosmarium phaseolus Brébisson	12, 15
Cosmarium portianum Archer	6
Cosmarium pseudoconnatum Norstedt	6
Cosmarium pseudopymidatum Lundell	6
Cosmarium quadratulum (Gay) DeToni	6
Cosmarium sexangularis Lundell	6
Cosmarium sp.	7, 8
Cosmocladium saxonicum DeBary	1
Cosmocladium sp.	2, 6
Desmidium aptogonum Brébisson	12
Desmidium baileyi (Ralfs) Nordstedt	12
Desmidium cylindricum Gréville	8
Desmidium sp.	6
Desmidium grevillii (Kütz.) Debary	12
Euastrum elegans Kützing	8
Euastrum sinuosum Lenor	8
Euastrum verrucosum Ehrenberg	6
Genicularia spirotaenia DeBary	12
Gonatozygon kinahani (Arch.) Rabenhorst	7, 12
Gonatozygon monotaenium DeBary	12
Gonatozygon pilosum Wolle	8, 12
Gonatozygon sp.	6
Hyalotheca dissiliens (Smith) Brébisson	1, 12
Mesotaenium sp.	12, 15
Micrasterias americana (Ehren.) Ralfs	4
Micrasterias fimbriata var. *spinosa* Bisset	8
Micrasterias furcata Ralfs	12
Micrasterias mahabuleshwarensis Hobs	8, 12
Micrasterias papilifera Brébisson	6
Micrasterias radiata Hassall	1, 2, 7, 8, 12
Micrasterias radiata var. *alata* Prescott & Scott	12
Micrasterias radiata var. *dichotoma* (Wolle) Cushman	12
Micrasterias radiata var. *gracillima* G.M. Smith	6, 12
Micrasterias radiosa Ralfs	7, 8, 12
Micrasterias radiosa var. *ornata* f. *elegantior* West & West	7
Micrasterias rotata (Grév.) Ralfs	1, 2, 4, 6, 8, 12
[b]*Mougeotia* sp.	1, 8, 12, 15
Netrium digitus (Ehren.) Tzigsoha & Rothe	8
[b]*Nitella flexilis* (L.) Agardh.	6, 9
[b]*Nitella megacarpa* T.F. Allen	11
Penium margaritaceum (Ehren.) Brébisson	6
Penium sp. Brébisson	7, 8
Pleurotaenium trabecula (Ehren.) Naegeli	12
Pleurotaenium sp.	1
[b]*Spirogyra* sp.	12
Spirotaenia condensata Brébisson	6
Spirotaenium sp.	7
Spondylosium granulatum Roy from *S. papilliosum* West & West	6
Spondylosium planum (Wolle) West & West	12
Spondylosium pygmaeum (Cooke) W. West	6
Spondylosium vertebratum var. *punctulatum* West & West	12
Staurastrum ankyroides Wolle	12
Staurastrum arctiscon (Ehren.) Lundell	1, 2, 6, 8, 12
Staurastrum curvatum W. West	3, 4
Staurastrum dakoti Taft	12
Staurastrum leptacanthum Nordst	12
Staurastrum limneticum Schmidle	4, 12, 15

Table 2 (continued)

CHAROPHYCEAE (continued)	
Staurastrum ophiura Lundell	1, 2, 7, 12, 13
Staurastrum ophiura var. *cambricum* (Lund.) West & West	8
Staurastrum orbiculare Ralfs	6
Staurastrum polymorphum Brébisson	6, 12
Xanthidium antilopaeum (Bréb.) Kützing	8
Xanthidium armatum (Bréb .) Rabenhorst	7
Xanthidium subhastiferum West & West	7
Xanthidium sp.	2, 6
[b]*Zygnema* sp.	8
HETEROKONTOPHYTA	
TRIBOPHYCEAE	
Characiopsis cylindrica (F.D. Lamb) Lemmermann (described as *Characium cylindricum*, a green alga)	1
Chlorosaccus sp.	6
Ophiocytium capitatum Wolle	8
[b]*Vaucheria* sp.	6
CHRYSOPHYCEAE	
Chlorochromonas minuta Lewis	12, 15
Chromulina ovalis Klebs	12, 15
Chromulina sp.	7, 10
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Mallomonas caudata Irvanoff	10, 15
Mallomonas sp.	10, 12
Uroglena volvox Ehrenberg	10
Uroglenopsis americana Lemmermann	10
Unknown flagellate sp.	1, 12
Unknown flagellate sp.	2, 12
SYNUROPHYCEAE	
Synura adamsi G.M. Smith	10
Synura sphagnicola Korshikov	10
Synura uvella Ehrenberg	10
Synura sp.	10, 12, 15
BACILLARIOPHYCEAE	
[b]*Achnanthes lanceolata* (Breb.) Grün var. *lanceolata*	16
[b]*Achnanthes linearis* (Wm. Sm.) Grün var. *linearis*	16
[b]*Achnanthes minutissima* Kützing var. *minutissima*	16
[b]*Achnanthes* sp.	13, 15
[b]*Amphora ovalis* var. *affinis* (Kütz.) Van Heurck ex DeToni	16
[b]*Anomoeoneis serians* var. *brachysira* (Bréb. ex Kütz.) Hustedt	17
[b]*Anomoeoneis serians* (Breb ex Kütz) Cleve var *serians*	16, 17
[b]*Anomoeoneis vitrea* (Grün) Ross var. *vitrea*	16
Asterionella formosa Hassall	12
[b]*Caloneis bacillum* (Grün) Cleve var. *bacillum*	16
[b]*Caloneis limosa* (Kütz.) Patr. var. *limosa*	16
[b]*Caloneis ventricosa* var. *truncatula* (Grün) F. Meister	16
[b]*Caloneis ventricosa* (Ehren.) F. Meister var. *ventricosa*	16, 17
[b]*Cocconeis placentula* var. *lineata* (Ehren.) Van Heurck	16
[b]*Cocconeis placentula* Ehrenberg var. *placentula*	16
Cyclotella bodanica Eulenstein	16, 17
Cyclotella comensis Grün	17
Cyclotella compta (Ehren) Kützing	8, 15
Cyclotella meneghiniana Kützing	7, 8, 12, 16
Cyclotella operculata (Agardh) Kützing	6
Cyclotella stelligera (Cleve & Grün) Van Heurck	17
[b]*Cymatopleura solea* (Bréb.) W. Sm.	17
[b]*Cymbella affinis* Kützing var. *affinis*	16
[b]*Cymbella affinis* Kützing var. *affinis* (teratological form)	16
[b]*Cymbella amphicephala* Naegeli ex Kützing var. *amphicephala*	16
[b]*Cymbella cuspidata* Kützing var. *cuspidata*	16
[b]*Cymbella delicatula* Kützing var. *delicatula*	16
[b]*Cymbella inaequalis* (Ehren.) Rabenhorst var. *inaequalis*	16
[b]*Cymbella lunata* W.Smith var. *lunata*	16, 17
[b]*Cymbella minuta* Hilse ex Rabenhorst var *minuta*	16
[b]*Cymbella naviculiformis* Auerswald ex Heiberg var. *naviculiformis*	16
[b]*Cymbella* sp.	12, 15
Diatoma sp.	6
[b]*Epithemia argus* (Ehren.) Kützing var. *argus*	17
[b]*Eunotia incisa* W. Smith ex W. Gregory var. *incisa*	16
[b]*Eunotia pectinalis* (O. Mull.) Rabenhorst var. *pectinalis*	16
[b]*Eunotia pectinalis* var. *undulata* (Ralfs) Rabenhorst	16
[b]*Eunotia sera* var. *diadema* (Ehren.) Patrick	16
[b]*Eunotia valida* Hustedt var. *valida*	17
[b]*Eunotia* sp.	12
Fragilaria bicapitata A. Mayer var. *bicapitata*	16
Fragilaria brevistriata var. *inflata* (Pant.) Hustedt	16, 17
Fragilaria constrictica Ehrenberg var. *constricta*	17
Fragilaria contruens (Ehren.) Grün var. *construens*	16, 17
Fragilaria contruens var. *venter* (Ehren.) Grün	17
Fragilaria pinnata Ehrenberg var. *pinnata*	16, 17
Fragilaria virescens. var. *capitata* Østrup	17
Fragilaria sp.	8, 12, 15
[b]*Frustulia rhomboides* (Ehren.) DeToni var. *rhomboides*	16
[b]*Frustulia vulgaris* (Thwaites) DeToni var. *vulgaris*	17
[b]*Gomphonema acuminatum* Ehrenberg var. *acuminatum* ("coronata")	16
[b]*Gomphonema acuminatum* var. *elongatum* (W. Sm.) Carr	16
[b]*Gomphonema affine* Kützing var. *affine*	16, 17
[b]*Gomphonema angustatum* (Kütz.) Rabenhorst	13, 15
[b]*Gomphonema angustatum* (Kütz.) Rabenhorst var. *angustatum*	17
[b]*Gomphonema gracile* Ehrenberg emend Van Heurck var. *gracile*	17
[b]*Gomphonema intricatum* var. Kützing var. *intricatum*	16
[b]*Gomphonema intricatum* var. *vibrio* (Ehren.) Cleve	16
[b]*Gomphonema parvulum* Kützing var. *parvulum*	17
[b]*Gomphonema subclavatum* var. *commutatum* (Grün) A. Mayer	16
[b]*Gomphonema truncatum* var. *capitatum* (Ehren.) Patrick	16, 17
[b]*Gomphonema truncatum* var. *turgidum* (Ehren.) Patrick	16, 17
[b]*Gomphonema turris* Ehrenberg var. *turris*	16
[b]*Gomphonema* sp.	7, 8, 12
Melosira arenaria Moore	17
Melosira distans (Ehren.) Kützing	17
Melosira italica (Ehren.) Kützing	16
Melosira varians Agardh	12
Melosira sp.	12
[b]*Meridion* sp.	12
[b]*Navicula cryptocephala* Kützing var. *cryptocephala*	16
[b]*Navicula exigua* W. Gregory ex Grün var. *exigua*	17
[b]*Navicula gracilis* Ehrenberg	12, 15
[b]*Navicula integra* (W. Sm.) Ralfs. var. *integra*	17
[b]*Navicula minima* Grün	16
[b]*Navicula mutica* Kützing var. *mutica*	17
[b]*Navicula pupula* var. *capitata* Skrine & Meyer	17
[b]*Navicula pupula* var. *rectangularis* (Greg.) Grün	16
[b]*Navicula radiosa* Kützing var. *radiosa*	16
[b]*Navicula scutelloides* W. Smith ex W. Gregory var. *scutelloides*	16
[b]*Navicula scutiformis* Grün ex A.S. var. *scutiformis*	17
[b]*Navicula* sp.	12, 16
Neidium sp.	12

Table 2 (continued)

BACILLARIOPHYCEAE (continued)	
[b]*Nitzschia capitellata* Hustedt	16
[b]*Nitzschia linearis* (Ag.) W. Smith	17
[b]*Nitzschia palea* (Kütz.) W. Smith	16
[b]*Nitzschia sigma* (Kütz.) W.Smith	16
[b]*Nitzschia sinuata* (W. Smith) Grün var. *tabellaria*	16
[b]*Nitzschia tryblionella* var. *victoriae* Grün	17
[b]*Odontidium* sp.	6
[b]*Pinnularia abaujensis* (Pant.) Ross var. *abaujensis*	17
[b]*Pinnularia acrosphaeria* W.Smith var *acrosphaeria*	16
[b]*Pinnularia acuminata* var. *instabilis* (A.S.) Patrick	17
[b]*Pinnularia appendiculata* (Ag.) Cleve var. *appendiculata*	17
[b]*Pinnularia bogotensis* (Grün) Cleve var. *bogotensis*	17
[b]*Pinnularia formica* (Ehren.) Patrick var. *formica*	17
[b]*Pinnularia intermedia* (Lagerst.) Cleve var. *intermedia*	17
[b]*Pinnularia legumen* (Ehren.) Ehrenberg var. *lugumen*	17
[b]*Pinnularia maior* (Kütz.) Rabenhorst var. *maior*	17
[b]*Pinnularia maior* var. *transversa* (A.S.) Cleve	17
[b]*Pinnularia mesogongyla* Ehrenberg var. *mesogongyla*	17
[b]*Pinnularia nodosa* (Ehren.) W. Smith var. *nodosa*	17
[b]*Pinnularia parvula* (Ralfs) Cleve-Euler var. *parvula*	17
[b]*Pinnularia substomatophora* Hustedt var. *substomatophora*	17
[b]*Pinnularia viridis* var. *commutata* (Grün) Cleve	16
[b]*Pinnularia viridis* (Nitz.) Ehrenberg var. *viridis*	17
[b]*Pinnularia* sp.	7
[b]*Pinnularia* sp. (resembles *P. subcapitata* var. *hilsenna* of O. Muller [1898])	16
[b]*Stauroneis acuta* W. Smith var. *acuta*	16
[b]*Stauroneis phoenicenteron* f. *gracilis* (Ehren.) Hustedt	16
[b]*Stauroneis phoenicenteron* (Nitz.) Ehrenberg var. *phoenicenteron*	17
Stephanodiscus alpinus Hustedt	16
[b]*Surirella* sp.	12
[b]*Surirella tenera* W. Gregory	16
Synedra rumpens Kützing var. *rumpens*	17
Synedra tenera Agardh	12
Synedra ulna (Nitz.) Ehrenberg	12, 15, 16
Synedra ulna var. *longissima* (W.Smith) Brun	16
Synedra sp.	7, 8, 12
Tabellaria fenestrata (Lyngb.) Kützing	1, 3, 8, 12
Tabellaria fenestrata (Lyngb.) Kützing var. *fenestrata*	16, 17
Tabellaria fenestrata (Lyngb.) Kützing var. *fenestrata*. (ribbed form)	15, 16
Tabellaria flocculosa (Roth) Kützing	7, 8, 15
Tabellaria flocculosa (Roth) Kützing var. *flocculosa*	16, 17
Tabellaria quadriseptata Knudsen var. *quadriseptata*	17
Tabellaria sp.	2, 3, 12
Vanheurckia sp.	1
CRYPTOPHYTA	
CRYPTOPHYCEAE	
Chilomonas paramecium Ehrenberg	10, 12
Chilomonas sp.	10
Chroomonas norstedii Hansgirg	10, 15
Chroomonas sp.	10
Cryptochrysis commutata Pascher	10
Cryptomonas erosa Stein	10
Cryptomonas erosa var. *reflexa* Marsson	12
Cryptomonas obovoidea Pascher	10
Cryptomonas ovata Ehrenberg	10, 12, 15
Cryptomonas pusilla Bachman	12
Cryptomonas pyrenoidifera Geitler	12
Cryptomonas sp.	10, 12
Cyathomonas truncata Fromental	10
DINOPHYTA	
DINOPHYCEAE	
Ceratium hirundinella (O. Mull.) Dujardin	7
Glenodinium borgei (Lemm.) Schiller	8
Glenodinium cinctum Mueller	12
Glenodinium minimum (Langtzsch) Bachman	12
Glenodinium oculatum Stein	12
Glenodinium palustre (Lemm.) Schiller	12
Glenodinium pulvisculus (Ehren.) Stein	7, 12
Glenodinium sp.	10
Gymnodinium fuscum (Ehren.) Stein	10, 12
Gymnodinium rotundatum Klebs	10
Gymnodinium tatricum Woloszynska	12
Gymnodinium triceratium Skuja	10
Gymnodinium sp.	10, 12, 13, 14, 15
Gyrodinium sp.	10
Hemidinium nasutum Stein	6, 10
Hemidinium sp.	10
Peridinium cinctum (Muell.) Ehrenberg	8, 12, 14
Peridinium cunningtonni Lemmermann	12
Peridinium inconspicuum Lemmermann	7, 8, 10, 12, 15
Peridinium willei Huitfeld-Kaas	7, 8
Peridinium wisconsinense Eddy	12
Peridinium volzii Lemmermann	12
Peridinium sp.	10, 14
Urococcus sp.	3
EUGLENOPHYTA	
EUGLENOPHYCEAE	
Anisonema acinus Dujardin	10
Astasia sp.	10
Entosiphon obliquum Klebs	10
Entosiphon sulcatum Dujardin	10
Euglena oxyuris Schmarha	10
Euglena spirogyra Ehrenberg	10
Euglena sp.	10, 12
Notosolenus sp.	10
Peranema trichophorum (Ehren.) Stein	6, 7, 10
Peranema sp.	10
Phacus caudatus Huebner	6
Phacus longicaudus Huebner	6
Phacus pleuronectes Müller	6, 10
Phacus pyrum Ehrenberg	6, 10
Phacus triqueter (Ehren.) Dujardin	6
Phacus sp.	12, 15
Trachelomonas hispida Perty	10
Trachelomonas horrida Palmer	10
Trachelomonas sp.	13, 15
Tropidoscyphus sp.	10
CHLOROMONADOPHYTA	
CHLOROMONADOPHYCEAE	
Gonyostomum semen Drising	10

Table 3. Invertebrate fauna reported from Mountain Lake. Classification follows Ward & Whipple (1965) with taxa listed alphabetically under higher taxonomic categories. Numbers following taxa indicate sources: 1 = Williams (1930), 2 = Hutchinson & Pickford (1932), 3 = Ferguson et al. (1939), 4 = Coker & Hayes (1940), 5 = McCalla (1942), 6 = Roth & Neff (1964), 7 = Marland (1967). Taxa designated [b] are primarily benthic, other taxa are primarily planktonic. * = Genus valid but species not found in Biological Abstracts.

RHIZOPODA	
Difflugia sp. Leclerc	1,4
TURBELLARIA	
[b] *Bothrioplana semperi* M. Braun	3
[b] *Castrada* sp. O. Schmidt	3
[b] *Daliella* sp. [=*Dalyellia* sp. Fleming]	3
[b] *Euplanaria trigrina*[*]	3
[b] *Fonticola gracilis*[*]	3
[b] *F. morgani*[*]	3
[b] *Fuhrmannia* sp.[*]	3
[b] *Microstomum lineare* Muller	3
[b] *Planaria dactyligera* Kenk	3
[b] *Prorhynchus stagnalis* M. Schultze	3
[b] *Rhynchomesostoma rostratum* [=*rostrata*] Muller	3
[b] *Rhynchoscolex simplex* Leidy	3
[b] *Stenostomum grande*	3
[b] *S. kepneri*[*]	3
[b] *S. saliens*[*]	3
[b] *S. tenuicaudatum*[*]	3
[b] *S. tuberculosum*[*]	3
[b] *S. virginianum*[*]	3
[b] *Typhloplana* sp. Ehrenberg	3
ROTIFERA	
Chydorids	7
Conochilus sp. Hlava	1
Conochilus unicornis Rousselet	2,4,5
Notholca longispina[*]	2,4
OLIGOCHAETA	
[b] *Limnodrilus hoffmeisteri* Claparede	6
[b] Lumbriculidae	6
[b] *Tubifex templetoni* Southern	6
CLADOCERA	
Bosmina sp. Baird	7
Bosmina obtusirostris Sars.	5
Daphnia sp. O. F. Muller	7
Daphnia longispina O.F.Muller	1
Daphnia pulex Leydig em. Richard	2,4,5
Diaphanosoma brachyurum Lieven	1,2,4,5
OSTRACODA	
[b] *Candona* sp. Baird	6
COPEPODA	
Cyclops vernales[*]	5
Diaptomus eregonensis[*]	1
D. leptopus S. A. Forbes[*]	2,4,5
DIPTERA	
[b] *Chaoborus* sp. Lichtenstein	5
[b] *Chaoborus punctipennis* Say	6
[b] *Microtendipes* sp. Kieffer	6
[b] *Procladius culiciformis* L.	6
[b] *Tendipes attenuatus* Walk[*]	6
[b] *T. modestus* Say[*]	6

Eckroade's (1962) thesis on the geology of the Mountain Lake area largely duplicated Sharp's (1933) findings:

> *Lateral erosion of the stream valley in the Tuscarora* [=Clinch] *produced large blocks which crept down slope and down the dip into the valley and reached the outcrop of the Tuscarora where further movement downstream was arrested. Frost heaving of Tuscarora along its outcrop and movement of large blocks, probably by solifluction* [gradual slipping downslope], *produced more blocks which crept downstream and dammed against the already persistent blocks. Complete damming of the north end of the lake was accomplished by a filling of interstices in the bouldery deposit by smaller blocks and fragments and organic matter.*

Apparently Eckroade was the first to note the upper Ordovician Juniata sandstone Formation located between the lower Ordovician Martinsburg shale and lower Silurian Tuscarora (Clinch) sandstone. He also noted the Martinsburg was divided into three units, the two lower calcareous with limestone and the upper (at Mountain Lake) of "...brown-weathering thin- to medium-bedded sandstones and siltstones" (i.e., not calcareous, nor of limestone).

Whitford (1964) added a number of new phytoplankton taxa to the list for Mountain Lake (Table 2). He was one of the first to note in the shallows at the south end of the lake the scattered beds of the macrophyte *Ceratophyllum demersum* L. and the alga *Chara schweinitzii* A.Br. Two emergent vascular plants also were fairly common, namely *Isoetes engelmanii* A.Br. and *Alisma plantago-aquatica* L., first noted by Coker & Hayes (1940). Limnological data reported were pH 6.4-7.4, little buffering, Secchi disk transparency 2.5-7.0 m, orthophosphate-P <3 µg/l, nitrate-N <20 µg/l, silica 2.8 mg/l, much of this taken from Hutchinson & Pickford (1932).

Roth & Neff (1964) conducted the most thorough physical and chemical limnological study of the time on Mountain Lake. They included a study of the profundal fauna at 22 m depth: two species of tubificids, 1-2 species of ostracods, 4+ species of tendipedids, and *Chaoborus* sp. (Table 3). Attached macrophytes in the lake included the alga *Nitella flexilis* (first listed by Forest, 1954), the moss *Fontinalis antipyretica,* and the vascular plants *Isoetes engelmanii*, *Potamogeton natans*, *P. pectinalis*, *Elodea nuttallii,* and *Ceratophyllum demersum*.

Marland (1967) conducted the first paleolimnological study of Mountain Lake. He collected seven sediment cores–three for ^{14}C dating and four for microfossil analysis. The frequency of occurrence with core depth of >20 microfossil species was recorded. Especially noteworthy was the variation in percent composition of littoral and planktonic (*Daphnia* and *Bosmina*) cladocerans, suggesting occurrence of at least three prolonged periods in the past when Mountain Lake had low water levels (i.e., mostly littoral cladocerans). Marland (1967) suggested that the most recent low water level probably occurred about 1786, and this was supported by a 1794 survey filed in the Montgomery County Court House which showed "...changes in the outlet position of Pond Drain and the shape of the lake…[suggesting]…the lake to be 600-700 feet shorter and about 100 feet narrower." Thus, the lake would have been 25 feet (8 m) below full capacity. Marland (1967) was aware of 14 sawed tree trunks which must have once grown along the shore of a much smaller lake and that leakage through the Clinch boulders coupled with drought occurring in the small watershed with a relatively low 5:1 ratio of watershed area to lake area could easily explain the past fluctuations in lake levels. Most water entering Mountain Lake was from springs. Based on a maximum core bottom ^{14}C-dated age of 9180 ± 330 YBP (years before present) and Sharp's (1933) geological studies with proposed lake origin, Marland (1967) concluded that a periglacial climate with frost action and solifluction created the colluvium at the north end of the lake basin about 10,000 YBP, but a permanent lake may not have formed until 2,000 YBP. Addressing the trophic state of the lake, Marland (1967) noted that a compound quotient of 0.43 calculated for phytoplankton in the1960s was 0.91 in the early 1930s. He further noted that the planktonic diatom *Cosmocladium saxonicum* which characterized oligotrophic waters, was abundant in 1930, 1931, and 1935, but absent in 1964-1966. All this suggested eutrophication was beginning.

Obeng-Asamoa & Parker (1972) published the first year-round biological and chemical limnological study of Mountain Lake. Ranges in pH of 5.9-7.2, generally low concentrations of the ions NH_4^{+1}, NO_3^{-1}, PO_4^{-3}, SiO_2, SO_4^{-2}, Cl^{-1}, and Fe, as well as the summer orthograde oxygen curves with hypolimnetic oxygen never dropping below 8.0 mg/l, all suggested oligotrophy. Phytoplankton densities were low, but consisted of many species (Table 2). Desmids dominated in summer, *Cyclotella compta* dominated in winter and spring, and the green algae *Sphaerocystis schroeteri and Planktosphaeria gelatinosa* occurred year-round. Primary productivity using chlorophyll, oxygen, and ^{14}C methods all gave low values characteristic of oligotrophic waters. Highest productivity in summer occurred in the metalimnion which also showed oxygen supersaturation. *Cyclotella* cell counts and size ranges and microalgae beneath lake ice in winter suggested high winter productivity which may have been in part heterotrophic. Obeng-Asamoa (1971) and Obeng-Asamoa & Parker (1972) also listed the littoral macrophytes, namely *Alisma* sp., *Ceratophyllum demersum, Chara schweinitzii, Elodea nuttallii, Isoetes engelmannii, and Nitella flexilis.*

Simmons & Neff (1973) reported limnological data collected at Mountain Lake from 1965-68. ^{14}C primary productivity measurements in light and dark 300 ml BOD bottles at various depths on seven occasions showed values ranging over 0.9-482.2 mgC/m^2/d (average 209.4). In summer, productivity ranged as high as 85 mgC/m^3/d. They concluded that these values generally indicated oligotrophy.

Parker et al. (1975) conducted a geological investigation at Mountain Lake which led to the conclusion that the lake formed by "damming of the headwaters of a stream with talus (sliderock)". Such talus largely consisted of Clinch sandstone boulders that formed during the Quarternary perhaps 10,000 YBP when a periglacial climate with abundant frost action and solifluction prevailed. This origin for the lake is similar to or in agreement with Rogers (1884), Hutchinson & Pickford (1932), Sharp (1933), Eckroade (1962), and Marland (1967) who effectively ruled out the "natural solution collapse basin" idea of Ferguson et al. (1939) and Holden (1938). Parker et al. (1975) also stressed that the Clinch boulder sliderock dam was not completely sealed, which accounted for the lake level fluctuations and submerged tree trunks representing trees that had invaded and grown in the meadow created by prolonged drought-induced drop in lake levels. A ^{14}C date in a southern yellow pine trunk with 22 annual growth rings collected at 10 m depth in the then full lake gave a value of 1655 ± 80 (ca. 350 YBP).

Parker (1976) measured photosynthetic production in the lake at various depths during the summer of 1973 and obtained values of 380-886 mgC/m^2/d. These values were about twice those reported by Simmons & Neff (1973). Rather than eutrophication as an explanation, two variations in the ^{14}C method likely caused much of the differences: (1) Parker (1976) used more transparent

screw-capped bottles in place of the thick glass BOD bottles of Simmons & Neff - hence, more photosynthetically available radiation in Parker's measurements. (2) Parker measured not only cellular, but also extracellular, fixed carbon, the latter frequently amounting to $\geq$ 25% of the total. Significant extracellular products of photosynthesis are well-known features for oligotrophic lakes and oceans (see Parker & Parson, 1987).

Dubay (1976) and Dubay & Simmons (1979) addressed the phenomenon of the oxygen supersaturation in the summer metalimnion of Mountain Lake. The oxygen maximum in 1974 was at 7-10 m depth and very near to the 11 m depth of the maximum biomass of the attached *Nitella flexilis*. In contrast, they reported no correlation between the positive heterograde oxygen curve and the phytoplankton densities or their estimates of phytoplankton primary productivity. They concluded that *Nitella* rather than the phytoplankton was responsible mainly for the metalimnetic oxygen maximum.

Dubay (1976) and Dubay & Simmons (1981) compared the ash-free dry weight biomasses of macrophytes collected from five transects from 0-11 m in Mountain Lake using SCUBA. *Nitella flexilis* overwhelmingly dominated with $\geq$ 90% of the total macrophyte biomass at all except the shallowest depths. The biomasses of other macrophytes followed the sequence *Fontinalis novae-angliae*>*Ceratophyllum demersum*> *Anacharis canadensis* >*Chara braunii.*

Mikell et al. (1983) reported the first investigation of the effects of high dissolved oxygen on heterotrophic plankton communities, using Mountain Lake as a model. This lake often developed a metalimnetic oxygen maximum in summer, such that instead of saturated 0_2 levels of 10 mg/l at 8m, the dissolved 0_2 often reached supersaturation of 14 mg/l. Mikell et al. (1983) demonstrated that 42 mg 0_2/l inhibited heterotrophic bacterioplankton in Mountain Lake based on colony forming units (CFU) and D-[U-^{14}C]glucose incorporation into extractable lipid of the CFU, and respiration plus assimilation of the D-[U-^{14}C]glucose. Additions of superoxide dismutase or catalase did not produce a significant difference. Thus, exogenous oxygen byproducts apparently were not responsible and the inhibition from high 0_2 concentrations most likely was intracellular.

Seaburg et al. (1983) isolated 115 clonal, unialgal strains, 60 of which were from Mountain Lake, and tested their ability to grow between 2-40 °C. Of the total isolates, 63 came from $\leq$ 6 °C and 52 came from $\geq$ 20 °C habitats. Based on the temperature-growth responses alone, 24% of the plankton and 17% of the periphyton isolates could have been perennial or year-round in natural habitats. At 5 °C, 56% of the warm-water plankton isolates and 48% of the warm-water periphyton isolates were incapable of growth, suggesting likely summer algal strains. At 25 °C, 25% of the cold-water plankton and 13% of the cold-water periphyton isolates were incapable of growth, suggesting likely winter algal strains. This investigation demonstrated that temperature alone is an important factor regulating seasonal changes in algal community structure.

VanBrunt (1984) studied seasonal variations in protozoan colonization of polyurethane foam units suspended in Mountain Lake. Seasonal changes caused much instability in the colonization curves which spanned 21 days. VanBrunt's measurements of pH, hardness, alkalinity, dissolved 0_2, and temperature all resembled the data of most previous workers. The ciliates and flagellates (including some algae) were not consistently identified, but their structural differences allowed an estimate of the number of probable species in spring, summer, and fall.

Jervis (1988) and Jervis et al. (1988) showed that the dominant macrophyte in Mountain Lake first cited by Forest (1954) and perpetuated by later workers (i.e., Roth & Neff, 1964; Obeng-Asamoa & Parker, 1972; Dubay & Simmons, 1979) was not *Nitella flexilis*. Rather, the monospecific genus in the lake was *Nitella megacarpa* T.F.A.

Parson & Parker (1989a) reviewed the more recent stresses to the Mountain Lake ecosystem. These included seasonal leakage of septic tanks, leakage of phosphate-containing detergents from a laundromat, installation of a pipeline and pump system for bringing air conditioning coolant water from lake to hotel in hot weather, and construction of concrete piers and limestone paths. Changes to the lake included higher extractable chlorophyll a, higher phytoplankton productivity, changes in the species composition of the phytoplankton community, and a more persistent and enlarging hypolimnetic volume depleted in oxygen. These observations suggested eutrophication. Yet Parson & Parker (1989a) noted that the lake had several features resisting eutrophication: (1) The relatively well-preserved state of the natural vegetation within the lake basin; (2) the large volume of relatively clean precipitation, runoff, and spring water feeding the lake, which annually nearly matched the lake's volume; and (3) the limited recreational uses of the lake and watershed.

Parson & Parker (1989b) produced the first comprehensive list of algae observed in Mountain Lake. Their list comprised 331 taxa , of which only 92 had been reported by previous investigators. The 331 included 45 Cyanophyceae (blue-greens), 185 Chlorophyta (greens), 25 Bacillariophyceae (diatoms), 20 Chrysophyceae (golden), three Tribophyceae (yellow-greens), 23 Dinophyceae (dinoflagellates), 16 Euglenophyceae (euglenoids), 13 Cryptophyceae (cryptophytes), and

one Chloromonadophyceae (chloromonad).

Parker et al. (1991) showed by *in situ* measurements and calculations that the metalimnetic oxygen maximum at 6-10 m during late summer thermal stratification previously attributed to the macrophyte *Nitella* (Dubay & Simmons, 1979) most likely was due to the phytoplankton. At the depth of the metalimnion the biomass of *Nitella* was about 11x that of the phytoplankton, but the photosynthetic productivity of the phytoplankton was 25x that of the *Nitella* when the entire lake and not merely the water overlying the *Nitella* beds was included in the calculations. Highest productivity values occurred in 1989, namely 13.34 $mgC/m^3/h$ of the lake mean of 22.79 $mgC/m^2/h$; this was the year that the septic tanks first installed in the 1930s were removed, inducing temporary record high concentrations of PO_3^{-3} and NH_4^{+1} in the lake.

Parson (1988) and Parson & Parker (1993) measured NH_4^{+1} uptake by phytoplankton using ^{14}C-methylamine and estimated the K_m (concentration at which the rate of uptake equals one-half of the maximum) and V_{max} (maximum uptake velocity) at two-week intervals over 6 months (May 15-Nov. 18). V_{max} increased steadily May-July in parallel with major changes in the phytoplankton community. Cryptophytes dominated in May, green algae in June and July, blue-greens July-October, and greens October-November. With blue-green dominance, V_{max} declined. K_m values increased May-July, but no correlation occurred thereafter. The coincidence of V_{max} and K_m values for ^{14}C-methylamine uptake and changing phytoplankton community structure suggested that the succession of algal communities may be occurring in response to differences in NH_4^{+1} affinities and uptake rates.

Beaty & Parker (1994) and Beaty (1995) reviewed information suggesting that Mountain Lake may have been undergoing eutrophication from oligotrophic to a meso-oligotrophic state. They included seasonal data for 1970-71 and 1985-93 which suggested trends toward $>NO_3^{-1}$ (especially 1990), $> NH_4^{+1}$ (especially 1989 +1990), $>^{14}C$ primary productivity (especially 1989), > hypolimnetic oxygen deficits (especially 1989), and probable anoxic sediments below 25m depth.

Beaty (1995) and Beaty & Parker (1996a) examined the relative importance of four phytoplankton size classes (pico-, nano-, micro-, and macro-) during thermal stratification in Mountain Lake. Based on ^{14}C-fixation rates, the microplankton (20-200 µm), which were most important in cell number and cell volume, contributed 95% of the total primary productivity. The picoplankton (<2 µm) ranked second in importance producing about 5% of the total primary productivity. The relatively small numbers of nano- (2-20 µm) and macro-plankton (>200 µm) contributed little primary productivity. The herbivore (second) level of the food chain (*Bosmina, Daphnia, Cyclops, Diaptomus*) appeared closely tied to grazing on the abundant microplankton although not necessarily equally over the 20-200 µm size range.

Beaty (1995) and Beaty & Parker (1996b) studied the affect of nutrient additions on *in situ* ^{14}C-primary productivity on the four phytoplankton size classes in Mountain Lake. Adding $P0_4^{-3}$, NH_4^{+1}, and sometimes NO_3^{-1} stimulated photosynthesis over 48 h, especially for the most dominant microplankton (20-200 µm), before any increase in cell numbers occurred. These findings suggested that any future increases in PO_3^{-3} and/or NH_4^{+1} could lead to eutrophication.

Cawley et al. (1999) reevaluated the trophic state of Mountain Lake. Orthophosphate [PO_3^{-3}] had been higher during 1980-90 than in years before 1980 but had returned to oligotrophic levels by 1997 [1.5 ug P/l] and 1998 [2.2 ug P/l]. Ratios of inorganic N:P of 143:1 and 235:1 indicated that phosphorus was the primary limiting nutrient regulating the oligotrophic state. Levels of dissolved SiO_2, about the same in previous studies, probably were limiting to many planktonic diatoms. Major phytoplankton algal taxa also were examined (Table 2).

Cawley et al. (2001b) reexamined the geology, hydrology, and morphometry of the lake and vicinity. A fracture trace analysis using resistivity measurements in the area confirmed that a lineation feature running SE to NW within and on both sides of the lake basin, including along Pond Drain, was actually a crevice or fault through which water probably could leave or enter during very dry (leaving) or excessively wet (entering) seasons. However, they added "...some water loss may also occur as leakage through Clinch sandstone colluvium at the northwest end of Mountain Lake, as proposed by earlier workers (Parker et al., 1975)."

The Clinch colluvium and natural dam were created by a periglacial climate with frost action and solifluction along with either a collapse of a cliff or the gradual creeping of boulders down slope, agreeing with several earlier workers cited in this review. Thus, Cawley et al. (2001b) modified these earlier assertions of the origin of Mountain Lake as follows: In addition to probable water losses through the Clinch colluvium, water losses or gains through the sediment-free deep crevice or fault at 33 m accompanies conduit erosion and periodic downsettling of overlying Clinch sandstone boulders. These processes also have been involved in the mechanisms for Mountain Lake's origin and periodic water-level fluctuations.

Cawley & Parker (2001) designed and built a new percussion coring device which enabled collection of seven sediment cores from Mountain Lake for analysis of the lake's paleohistory going back 6100 years (Cawley et al., 2001a). Their analysis of littoral: planktonic diatom ratios and forest: field pollen ratios in the sediment core

layers enabled recognition of six prolonged periods when the lake probably was nearly dry or very small in size. Based on ^{14}C dating, these six low-water periods occurred at about 100, 400, 900, 1200, 1800, and 4100 YBP. The low-water intervals of 900 and 1200 YBP perfectly match the low-water periods suggested from littoral: planktonic cladoceran ratios by Marland (1967). Other low-water periods may well have occurred, but of too short duration for accurate detection within the sediment cores. The core contents at 6100 YBP suggested the existence of a full lake, contradicting Marland's (1957) suggestion that a full lake may not have begun until 2000 YBP. New diatom taxa also were noted by Cawley et al. (2001a) (Table 2).

Cawley et al. (2002) reported an analysis of diatoms in mini-cores taken from Ekman dredge samples dating back an estimated 100 years. They noted at least 66 diatom taxa belonging to 25 genera (Table 2); 12 of the 66 taxa were new records for Virginia inland waters. Planktonic diatoms were sparse, but attached epipelic and epiphytic diatoms were abundant. Cluster analysis of diatom counts from the recent lake sediments suggested seven delineated regions or assemblages within this relatively small lake. The assemblages were divided between shallow (primarily pennate) and deep-water (primarily centric) taxa.

DISCUSSION

Table 1 provides an update of the figure in Parker et al. (1975) showing the periods in the historic record when Mountain Lake was full (100%) or significantly lower (<100%). Cawley et al. (2001a) and data from Marland's (1967) dissertation showed that the lake prior to Gist's 1751 discovery (Johnston, 1898) also had periodic prolonged low-water levels. Even earlier, Parker et al. (1975) reported that a ^{14}C date from an in-place southern yellow pine stump collected from 10 m depth grew at the edge of a lower lake about 1655 ± 80. The pine may have been *P. pungens* Lamb. which occurs in the area, but positive distinction from 6-7 other species is not possible using wood anatomy alone. In April 2002, a drop of 7 m in lake level exposed another in-place tree trunk. This eastern white pine [*Pinus strobus* L.] was collected and ^{14}C-dated at 110 ± 50 YBP. The most likely interval when this tree grew for about 20 years along the shoreline of the lake was perhaps 1885-1904 based on Table 1 information.

The best explanation for the prolonged low-water phenomenon in Mountain Lake relates directly to the origin of the lake proposed by most previous investigators, namely by incomplete damming of a stream with Clinch sandstone colluvium (Hutchinson & Pickford, 1932; Sharp, 1933; Eckroade, 1962; Marland, 1967; Parker et al., 1975). [For additional details of the geology and colluvium, see Schultz et al., 1986; Mills, 1988; Schultz & Southworth, 1989] Cawley et al. (2001b) also proposed that major water loss may occur through a southeast-to-northwest fracture trace or fault located at the lake's maximum depth. This fracture trace or fault was easily detected using sonar bathymetric mapping. In fall 2001, three divers (Jacob Waller, Scott Elliot, Brian McCormick from Virginia Tech) located the fracture trace and identified a 1.5 x 2.5 ft (0.5 m x 0.8 m), sediment-free hole at 33 m depth of a full lake (Waller et al., pers. comm.). Such a hole might well serve as a conduit for water and sediment escape or entry, as proposed by Cawley et al. (2001b). No detectable currents near the hole were noted, however, during their brief visit. Subsequently, the divers confirmed the presence of numerous probable cracks or holes between Clinch boulders at shallower depths in the northwest corner of Mountain Lake. Thus, a combination of drought (prolonged below-normal precipitation) and excessive water losses through colluvial Clinch boulders and the deep fault has resulted in the periodic low-water levels. The impact of drought is all the more pronounced because of the very small ratio (5:1) of watershed to lake area.

Parker et al. (1975) calculated that about half of the water entering Mountain Lake must be leaving through subsurface cracks and holes in Clinch boulders. During 1997-2002, a prolonged drought with significantly below-normal annual precipitation accompanied a fairly steady drop in lake level to a point where the lake was only about 72% of full capacity, thus 9.2 m (30 ft) below full lake level in early November 2002. In November 2002 and subsequent months through August 2003, the lake level began rising as above-average precipitation returned to the region. By the end of August 2003, Mountain Lake reached full capacity again (Table 1). Figures 2a and 2b show Mountain Lake in August 1985 and August 2002, respectively. The below-normal precipitation in 1997-2002 has been documented through examination of the precipitation records of the University of Virginia's Mountain Lake Biological Station and Miles C. Horton Research Center. At these two nearest sites to Mountain Lake the annual precipitation in 1997-2001 was about 70% of annual means for 1982-1996, the latter being when the lake was consistently 100% full.

As the drought continued through 2001, no surface outflow from the lake to Pond Drain occurred. In fact, Pond Drain showed no surface water for a distance of up to nearly 1.0 km northwest of the lake. However, at just over 1.0 km northwest of the lake, suddenly large volumes of water came to the surface. A United States Geological Survey topographical map (Interior quadrangle) showed that this distance from the lake along Pond Drain has an elevation of about 40-45 m lower than the lake surface or about 8-13 m below the crevice and

Fig. 2A. Aerial photograph of a full Mountain Lake in August 1985 looking northward (photograph by Bruce Parker).

Fig. 2B. Aerial photograph of an 80% full Mountain Lake in August 2002 looking southward and showing non-forested meadow, especially at the south end (photograph by Jim Walker).

hole at the bottom of the lake. From several locations in this part of Pond Drain, Cawley & Parker (unpubl. data) collected fine sediments which they processed for diatom identification using standard procedures (Cawley et al., 2001a). The diatoms identified were mostly centric taxa identical to those occurring in Mountain Lake and uncharacteristic of diatom taxa living in mountain streams (Cawley & Parker, unpubl. data). They concluded that the sediments and diatoms from Pond Drain 1.0 km from the lake most likely were coming from the lake through the colluvial cracks and deep hole.

Table 2 lists 448 algal taxa representing 10 classes that have been reported in 17 investigations. While some of the algal taxa have been renamed recently, the earlier names have been retained here to avoid confusion. This is a 26% increase over the 331 taxa previously tallied by Parson & Parker (1989b). The new additions are largely of benthic diatom taxa described by Cawley et al. (2001a, 2002) which were not investigated by earlier workers. Of course, some of the algae in Table 2 have been reported only once or only during certain short seasons, while others have been more frequent and persistent. For example, Beaty & Parker (1994) compared the 10 most abundant phytoplankton for July 1970 (from Obeng-Asamoa, 1971) and July 1985 (from Parson & Parker,1989a). Table 4 repeats this list, and it will be seen that the 10 most abundant taxa in 1970 and 1985 were completely different. Table 4 also includes the 10 most abundant taxa for July 1997 and 1998 (from Cawley et al., 1999), and it will be noted that 8 taxa are different from 1970 and 1985. However, *Quadrigula chodatii* was in the top 10 in 1970 and *Scenedesmus bijuga* was in the top 10 in 1985. Parson & Parker (1989a) noted that *S. bijuga* became abundant following the addition of limestone paths near the south end of the lake and suggested that this species was stimulated by increased bicarbonate from the limestone. In 1998, tons of additional limestone were added to expand the parking area and create more paths at the south end of the lake. Thus, bicarbonate increase once again may explain the resurgence of *S. bijuga* back into the top 10.

Table 3 is the counterpart of Table 2 for the microfauna reported in seven investigations at Mountain Lake. The list includes 43 taxa belonging to eight orders. Although the list seems short compared to Table 2, many of the algae in Table 2 also can be classified as protozoa but have not been repeated in Table 3. In addition, fewer studies of the microfauna have been conducted in Mountain Lake.

During 1997 and 1998, Cawley et al. (1999) examined the levels of several nutrients in the lake, the five input streams, and year-round precipitation. These data have been repeated in Table 5, which shows that N, especially as NO_3^{-1}, was very high relative to P as PO_4^{-3}. Thus, the N:P ratios were 143:1 and 235:1, implicating P as the very severe limiting nutrient which primarily sustains the oligotrophic state of Mountain Lake. As Cawley et al. (1999) noted, in both freshwaters and oceans a balanced

Table 4. Phytoplankton ranks for July 1970 (Obeng-Asamoa, 1971), July 1985 (Parson & Parker, 1989a), and July 1997-1998 (Cawley et al., 1999) for Mountain Lake.

Rank	1970	1985	1997-98
1	*Bambusina brebissonii*	*Scenedesmus bijuga*	*Chlorella vulgaris*
2	*Staurastrum ophiura*	*Asterionella formosa*	*Gloeocystis planktonica*
3	*Radiofilum confunctivum*	*Gymnodinium* sp.	*Chlamydomonas* sp.
4	*Quadrigula chodatii*	*Cyclotella meneghiniana*	*Chroomonas norstedii*
5	*Sphaerocystis schroeteri*	*Chilomonas paramecium*	*Chlorochromonas minuta*
6	*Mougeotia* sp.	*Peridinium wisconsinense*	*Scenedesmus bijuga*
7	*Micrasterias radiosa*	*Chroococcus minutus*	*Crucigenia quadrata*
8	*Quadrigula lacustris*	*Spondylosium planum*	*Quadrigula chodatii*
9	*Micrasterias radiata*	*Chromulina ovalis*	*Cyclotella compta*
10	*Staurastrum arctiscon*	*Tabellaria fenestrata*	*Synedra ulna*

Table 5. Concentrations of PO_4 -P, NH_4-N, NO_3-N (as µg/L), SiO_2 (as mg/L), and the N:P ratio in Mountain Lake, input streams, and rainwater in 1997, 1998 (Cawley et al., 1999) and 2001 (new data).

Year	Variable	Lake	Input Streams	Rainwater	Lake N:P Ratio
1997	PO_4-P	1.5	4.8	20.7	
	NH_4-N	14.0	25.0	269.7	
	NO_3-N	200.0	1320.0	994.0	143:1
1998	PO_4-P	2.2	8.2	110.0	
	NH_4-N	16.0	25.0	503.0	
	NO_3-N	500.0	1359.0	2550.0	235:1
	SiO_2	0.39	0.44	0.38	
		Lake North	Lake South	Wetland	
2001	PO_4-P	0.50	0.25	5.75	
	NH_4-N	62.0	70.0	90.0	
	NO_3-N	27.0	18.0	28.0	236:1

N:P ratio will be 16:1 to 17:1. In December 2001, water collections were made from both ends of the lake and analyzed by the same procedures used by (Cawley et al., 1999). Table 5 shows that both NO_3^{-1} and PO_4^{-3} had dropped since 1997-98. However, the N:P ratio of 236:1 confirms that P remains the primary limiting nutrient.

The wetland and pond just south of the lake was constructed in 1997, then enlarged in 1998. A spring was opened at the surface just north of the hotel parking lot, creating a tiny cascade down the slope into the wetland and pond. Native algae, submergent and emergent vegetation quickly colonized this new habitat, forming a biological filter for water entering the lake. Table 6 lists the 13 most abundant taxa during the summers of these first two years of the wetland's existence. The list includes two algae and 11 non-algal taxa, a number of which were reported in earlier investigations of the lake and lake shore.

By contrast, Table 5 shows that PO_4^{-3} was high in the wetland, producing a nearly balanced N:P ratio of 21:1 Such a near-balanced ratio of these two nutrients will stimulate growth of algae and other vegetation, thereby removing most of the N and P before water is released into the lake. This most likely contributed to the lower concentrations of NO_3^{-1} and PO_4^{-3} in the lake during 2001.

A number of other invertebrate and vertebrate fauna common to Mountain Lake but little-studied there include

Table 6. Most abundant vascular plants and algae colonizing the new wetland at the south end of Mountain Lake during 1997 and 1998 (Identifications by B. Parker and Billie Jean Kirk using Godfrey & Wooten [1979, 1981] and confirmed by Tom Wieboldt). Voucher specimens deposited at the Massey Herbarium, Biology Department, Virginia Tech.

Species (& Family)	July 1997	Aug. 1998
Alisma subcordatum Raf. (Alismataceae)	x	x
Bidens frondosa L. (Asteraceae)		x
Callitriche heterophylla Pursh (Callitrichaceae)	x	
Eleocharis obtusa (Willd.) Schultes (Cyperaceae)	x	
Epilobium coloratum Biehler (Onagraceae)		x
Impatiens capensis Meerb. (Balsaminaceae)		x
Juncus subcaudatus (Engelm.) Cov. & S.F. Blake (Juncaceae)		x
Nitella megacarpa T.F.A. (Characeae)	x	
Onoclea sensibilis L. (Onocleaceae)		x
Polygonum hydropiper L. (Polygonaceae)	x	x
Polygonum sagittatum L. (Polygonaceae)	x	x
Spirogyra spp. (Charophyceae)	x	x
Veronica angallis-aquatica L. (Scrophulariaceae)	x	x

the crayfish *Orconectes juvenilis* (Hagen), red-spotted newt *Notophthalmus viridescens viridescens* (Rafinesque), bullfrog *Rana catesbeiana* (Shaw), bluntnose minnow *Pimephales notatus* (Rafinesque), redbreast sunfish *Lepomis auritus* (Linnaeus), bluegill *Lepomis macrochirus* (Rafinesque), largemouth bass *Micropterus salmoides* (Lacepede), and rainbow trout *Onchorhynchus mykiss* (Walbaum). These are probably all native species except for the rainbow trout which is stocked every few years to enhance the sport fishing. No attempt will be made here to list the numerous aquatic insects that abound in the lake and amongst other ecological roles provide valuable food sources for other fauna.

In 2000, the hemlock woolly adelgid (*Adelges tsugae*) arrived at Mountain Lake and began to spread throughout the forest parasitizing the hemlocks (*Tsuga canadensis* (L) Carr.). Over several years, this parasite can inflict severe damage to hemlock trees, ultimately causing death (Mayer et al., 2002). The hemlock-rhododendron forest surrounding much of the lake provides significant scenic beauty. Consequently, in 2001, Scott Salom and Tom McAvoy of the Virginia Tech Department of Entomology, initiated a program to control the woolly adelgid. Hundreds of hemlock trees received the recommended doses of Merit in the soil around their roots. Merit is a systemic pesticide for the woolly adelgid; the pesticide is taken up by the roots and transported to the branches and leaves throughout the tree reaching sites occupied by the woolly adelgid and killing the insect. Then, in winter 2002, Salom and McAvoy began releasing two beetle predators known to feed quite exclusively on the woolly adelgid: *Pseudoscymnus tsugae* and *Laricobiua nigrinus.* This program of chemical treatment and attempted biological control of the woolly adelgid will continue until its effectiveness can be assessed.

CONCLUDING REMARKS

This review included nearly 50 scientific studies conducted over the last 150 years on Mountain Lake, Giles County, Virginia. This lake is unique through its geology, hydrology, possession of a fault and colluvium, and unusually high aquatic species diversity. No other lake in the world apparently possesses this combination of features. No doubt, researchers will continue to find interest in this lake in future years.

ACKNOWLEDGMENTS

Special thanks go to The Wilderness Conservancy and the hotel staff at Mountain Lake for permitting numerous visits, providing boats, and other support for research at the lake. Thanks go also to the Virginia Tech Library for acquisition of relatively obscure theses, papers, and publications.

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Banisteria, Number 22, 2003

The Flora and Fauna of Virginia Army National Guard OMS No. 1 and No. 2 near Sandston, Henrico County, Virginia

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INTRODUCTION

In 2000, the Virginia Department of Military Affairs contracted with the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) to conduct a biological inventory of plant and animal species on the lands included in Virginia Army National Guard (VA ARNG) installations Organizational Maintenance Shop (OMS) No. 1 and No. 2, located near Sandston, Virginia. The intent of the project was to provide VA ARNG with species lists of plants and animals found on the installations so as to document the presence, distribution, and status of significant elements of biodiversity. A major focus of the study was inventory for rare species listed under the federal Endangered Species Act of 1973, as amended, the Virginia Endangered Species Act, the Virginia Endangered Plant and Insect Act, and rare plant and animal lists maintained by DCR-DNH (Roble, 2001; Townsend, 2001). The practical goal of the inventory was to assist facility personnel in decisions concerning land use and management in the event that rare, threatened, or endangered species or significant natural communities were encountered.

STUDY AREA

OMS No. 1 and No. 2 are located about 3 km SE of the town of Sandston in Henrico County, Virginia, and about 12 km ESE of Richmond. The property consists of 21.4 contiguous ha that are bordered by the Richmond International Airport to the west and by forested habitats to the north, south, and east. Other land uses in the area include low to high-density suburban development and agriculture.

The headwaters of White Oak Swamp (a creek) are located to the north of the property; this creek is a tributary of the Chickahominy River in the James River watershed. Two northeast-trending intermittent branches of White Oak Swamp cross the property. These streams and the small headwater seeps that feed them create a mosaic of forested upland and forested wetland habitats. Two vernal pools are located along these drainages. Elevations on the property range from 41 to 47 m.

The property is located within Virginia's Inner Coastal Plain physiographic province just east of the Fall Line. This province is characterized by poorly consolidated sediments eroded from highlands to the west and deeply underlain by the crystalline rocks characteristically exposed to the west in the Piedmont physiographic province. One major soil association is found on the property, Kempsville-Atlee-Duplin, which is characterized by deep, well-drained and moderately well-drained soils that have a dominantly sandy clay loam or clay subsoil (Clay, 1975). The climate of Henrico County is classified as humid subtropical, with warm to hot summers and mild winters and an average annual precipitation of 112 cm (Clay, 1975).

OMS No. 1 and No. 2 are active VA ARNG facilities used for training and light vehicle maintenance. U.S. government records indicate that the property has been owned by the U.S. Army and utilized by VA ARNG since the 1940s. Land use prior to this time is unknown (Shea & Smith, 1996).

Natural habitats within the survey area have been severely altered from pre-European settlement times, including hydrologic alterations in the form of stream channelization and ditching. Buildings and parking areas are confined to two areas on the southern and western perimeter of the property, and several roads, both paved and dirt, traverse the area. A perimeter fence surrounds the entire property, and a narrow strip along the inside of the fence is kept open by mowing. Other disturbed habitats include lawns, an infrequently-

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mowed field, and an open utility right-of-way with both upland and saturated wetland habitats.

OMS No. 1 and No. 2 lie within Braun's (1950) Oak-Pine region, which includes Virginia's southern Piedmont and the Inner Coastal Plain north of the James River. This region is generally considered a transition zone where pines characteristic of the southeastern United States become more common in oak-dominated forests east of the Appalachians. Two of Virginia's natural community types as described by Fleming et al. (2001) have been identified on the property: Mixed Oak/Heath Forest and Coastal Plain/Piedmont Acidic Seepage Swamp.

Mixed Oak/Heath Forests are oak-dominated forests of infertile uplands with submesic to xeric moisture regimes and soils that are highly acidic (nutrient poor). The presence of thick duff layers and inflammable shrubs makes this community susceptible to frequent fires and, subsequently, favors the recruitment of oaks. At OMS No. 1 and No. 2, these upland oak species are *Quercus alba* (white oak), *Q. coccinea* (scarlet oak), *Q. falcata* (southern red oak), *Q. rubra* (northern red oak), *Q velutina* (black oak), and *Q. stellata* (post oak). Pines are also important canopy associates; at OMS No. 1 and No. 2 *Pinus taeda* (loblolly pine) and *P. virginiana* (Virginia pine) are prevalent. Hickories are usually unimportant, and no hickory species were observed during the inventory. *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum) are prevalent in the understory, and dense colonies of heath-family plants dominate the shrub layers. At OMS No. 1 and No. 2, abundant upland ericads include *Vaccinium pallidum* (early lowbush blueberry), *V. stamineum* (deerberry), *V. fuscatum* (hairy highbush blueberry), *Gaylussacia baccata* (black huckleberry), and *Rhododendron atlanticum* (dwarf azalea). Herbaceous species are sparsely distributed (Fleming et al., 2001).

Coastal Plain/Piedmont Acidic Seepage Swamps are oligotrophic (nutrient-poor) wetlands cloaked in deciduous or mixed forests. They are found along stream headwaters and toe-slopes where groundwater is discharged as surface seepage and slowly drained away as stream flow. Drainage patterns are generally diffuse in these saturated wetlands and typically characterized by braided channels interspersed with *Sphagnum*-covered hummocks. Substrates are sandy or peaty (Fleming et al., 2001). At OMS No. 1 and No. 2, this community type is poorly developed and has been disturbed by forest clearing, stream channelization, and ditching. Canopy species there include *Acer rubrum*, *Nyssa sylvatica*, and *Pinus taeda*; small trees and shrubs include *Magnolia virginiana* (sweetbay), *Clethra alnifolia* (sweet pepperbush), *Viburnum nudum* (possum-haw), and *Vaccinium formosum* (swamp highbush blueberry). The herb layer is diverse and rich in sedge species, including *Carex lonchocarpa* (southern long sedge), *C. seorsa* (weak stellate sedge), and *C. scoparia* (pointed broom sedge).

METHODS

Botanical

Botanical fieldwork was conducted by author AB and consisted of seven site visits between April and October 2001. A list was compiled of all plant taxa encountered at OMS No.1 and No. 2. Species that could not be identified in the field were collected and identified later using standard floras for the area, including Fernald (1950), Radford et al. (1968), and Gleason & Cronquist (1991). A draft flora in progress, (Weakley 2000), was consulted for more recent treatments. Plant specimens that represented new county records as determined by Harvill et al. (1992) and updated information provided by one of its authors (G.P. Fleming) were pressed, labeled, and deposited at the herbarium of Virginia Polytechnic Institute and State University (VPI) in Blacksburg, Virginia.

Rare plant searches focused on *Helonias bullata* (swamp-pink) and *Isotria medeoloides* (small whorled pogonia). Both of these species are listed as federally threatened and state endangered. *Helonias bullata* is known to occur in the Coastal Plain/Piedmont Acidic Seepage Swamp natural community type, and a known population is located about 10 km ESE of OMS No. 1 and No. 2 (DCR-DNH, unpublished data). *Isotria medeoloides* occurs in infertile, mesic to submesic upland forests and appears to favor areas with sparse shrub and herb layers. Coastal Plain occurrences of this orchid in Virginia are known from Williamsburg City and the following counties: Caroline, Gloucester, James City, King William, and New Kent (Ware, 1991; DCR-DNH, unpublished data). The small size of the study area allowed for intensive searches for these two plants when appropriate habitats were encountered.

Zoological

Zoological fieldwork was led by KLD and consisted of 30 site visits between April 2001 and April 2002. Inventory of animal species entailed a full complement of sampling techniques as follows:

1. Baited pitfall traps (PF) – Small 8 cm-diameter cups baited with rotting meat were buried with the rims at ground level and used for four days in June to attract carrion-feeding insects.

2. Bird surveys (BD) – Birds were inventoried using visual and aural survey techniques during three early morning (0600 h -1000h) site visits during the breeding season (May and June). In addition, owls were inventoried using tape playback calls for two nights in February.

3. Coverboards (CB) – Eight coverboards (ca. 0.6 x 1.2 m each) made of pressboard were placed in various locations at the onset of the inventory in May 2001 to assist in the survey of reptiles and amphibians. Boards were lifted during each subsequent site visit to determine the presence of targeted species.

4. Dip nets (DN) – Aquatic invertebrates were sampled with D-ring dip nets on three site visits in June and July.

5. Drift fences (DF) – Two drift fence arrays were established in May 2001 for the purpose of trapping reptiles, amphibians, small mammals, and invertebrates. Each array consisted of three 5 m lengths of aluminum flashing radiating out from a central pitfall trap made from a one-gallon can. Flashing was buried 10 cm into the ground in order to direct traveling animals towards pitfall traps that were installed at the end of each length. Pitfall traps were filled with equal parts antifreeze and 10% formalin to kill and preserve captures. A wire mesh was placed over pitfalls to discourage vertebrates from being caught, but was removed during nine trap nights of mammal trapping sessions (18-22 June, 13-16 August, 18-20 September).

6. Hand collection and visual/aural surveys (HV) – Reptiles and amphibians, as well as some invertebrates, were searched for and collected by hand in terrestrial habitats (12 hours of effort), where various cover objects were overturned in search of cryptic species. Opportunistic surveys for birds, amphibians, and mammals utilized visual and aural identification techniques.

7. Malaise trap (MA) – Flying insects were sampled with a Malaise trap set from mid-May to late August along an intermittent stream in the Coastal Plain/Piedmont Acidic Seepage Swamp community.

8. Minnow traps (MN) – Standard wire-mesh minnow traps were used to sample a variety of aquatic animals. Traps were baited with chicken livers and set overnight in shallow water for a total of seven nights in June.

9. Mist netting (MT) – Nocturnal bat surveys were conducted using 17 x 18 ft. (5.2 x 5.5 m) mist nets placed across appropriate corridor and aquatic habitats. Nets were set up at dusk on two nights (14 August, 18 September) and checked regularly for 3-5 hours.

10. Sherman live traps (SH) – Traps for small mammals were placed along the drift fences as well as in various natural habitats. Traps were baited with oats and peanut butter and left open for a total of nine trap nights (18-22 June, 13-16 August, 18-20 September).

11. Sugaring (SU) – Some nocturnal insects that are not attracted to UV-light come to bait. The bait used was a mixture of fermented beer, fruit, and sugar, which was applied to tree trunks during the two mist netting sessions. Moths were collected with a kill-jar and non-lepidopterans were collected in alcohol.

12. Sweep nets (SW) – Lepidopterans, odonates, tiger beetles, and other flying invertebrates were sampled opportunistically on most site visits to both terrestrial and aquatic habitats using sweep nets.

13. UV-Light traps (UV) – Nocturnal lepidopterans and other invertebrates were captured using standard bucket traps equipped with a blacklight (= ultraviolet) powered by a 12-volt gel-cell battery with ethyl acetate used as a killing agent. Traps were run overnight in a variety of habitats for twelve trap nights during the May-October period. During the two mist netting sessions, a UV-light was used with a white sheet. Moths attracted to the sheet were collected in a kill-jar and non-lepidopterans were collected in alcohol.

All invertebrate specimens collected during the study were preserved using standard methods (Martin, 1977). All lepidopterans were mounted on pins, odonates were preserved with acetone and stored in glassine envelopes, and other insects were stored in 70% isopropyl alcohol. Frogs and toads were the only vertebrate specimens collected from the pitfall traps; specimens were transferred to 35% isopropyl alcohol. Most specimens have been or will be deposited in the Virginia Museum of Natural History; some specimens may be deposited in the National Museum of Natural History and the reference collection (primarily Lepidoptera and Odonata) of DCR-DNH.

RESULTS AND DISCUSSION

Botanical

A total of 325 vascular plant species and subspecific taxa was recorded for OMS No. 1 and No. 2 (Table 1). These taxa are contained within 189 genera

and 70 families. Four families, the Poaceae (55 taxa), Asteraceae (47 taxa), Cyperaceae (33 taxa), and Fabaceae (22 taxa) comprise 48.3% of the flora. *Carex* is by far the largest genus with 17 taxa. The 66 non-native taxa represent 20.3% of the flora.

Included among the non-native taxa is a new Virginia state record, *Cerastium dubium* (doubtful mouse-ear chickweed). This weedy species has previously been reported in North America from Illinois, Ohio, Kentucky, Tennessee, Arkansas, Mississippi, Oregon, Washington, and Idaho (Kartesz, 1999; Chester & Wofford, 2000). It is native to western France and Sicily to central Russia (Shildneck & Jones, 1986). Thirteen new Henrico County records were collected (Table 1).

Neither *Helonias bullata* nor *Isotria medeoloides* was found during the survey. The Coastal Plain/ Piedmont Acidic Seepage Swamp community at OMS No. 1 and No. 2 is small and poorly developed. There did not appear to be sufficient seepage to support *Helonias*. Uplands at the study site are mostly cloaked in a dense ericaceous shrub layer; thus, it is not surprising that *Isotria* was not found. No other rare, threatened, or endangered plant taxa were located during the inventory.

Zoological

Sixty-eight species of vertebrates were identified at OMS No. 1 and No. 2 during the course of the inventory, including 9 amphibians, 8 reptiles, 3 fish, 42 birds, and 6 mammals (Table 2). Two groups that are not well represented in the results are salamanders and small mammals. No salamanders were discovered on the property despite extensive searches. The year of the survey was particularly dry, and this may account for the difficulty of locating salamanders on the surface. Small mammals are typically difficult to inventory and often require many trap nights for few captures. It is likely that other species of mice, voles, and shrews exist on the property, but only the white-footed mouse (*Peromyscus leucopus*) was captured.

Vertebrate species associated with aquatic habitats (fish, aquatic turtles, and frogs) were located exclusively in the semipermanently flooded habitats of a tributary to White Oak Swamp. All other vertebrates identified during the inventory were common throughout the study area, showing little habitat specificity. No rare, threatened, or endangered species of vertebrates were expected from the survey area based on available habitats and regional patterns, and all vertebrate species identified in the inventory are considered common in the region. No new county records of vertebrates resulted from the inventory.

The majority of Lepidoptera and Odonata captured during the inventory have been identified, yielding 124 species of Lepidoptera, 16 of which were new county record butterflies and skippers (Opler et al., 1995), and 20 species of Odonata, including seven new county records (Carle, 1982; Table 2). Dragonfly species collected included *Libellula flavida* (yellow-sided skimmer), an uncommon species in Virginia (Carle, 1982). Numerous other invertebrates were collected but will not be identified in the near future due to funding and expertise constraints. No rare, threatened, or endangered species of invertebrates were identified during the inventory.

The method of inventory that yielded the greatest number of species was hand collection and visual surveys (i.e., opportunistic searching). Nevertheless, nine of the vertebrate species were captured with an intensive trapping method, such as the drift fence arrays, mist nets, or minnow traps, thus justifying continued use of labor- and material-intensive methods in comprehensive inventories.

ACKNOWLEDGMENTS

Funding for this inventory was provided by the Virginia Department of Military Affairs. We would like to thank the contract administrator, Major Gary Williamson, and the personnel of the facility, particularly Dan Seay, for their assistance with access to restricted areas and for providing logistical assistance and information on areas of interest. Thomas F. Wieboldt of Virginia Polytechnic Institute and State University assisted with the identification of plants collected for this project. DCR-DNH staff who assisted with data collection and processing are Anne C. Chazal, Gina M. Pisoni, Sandra Erdle, Philip A. Gipe, Steven M. Roble, Christopher S. Hobson, and J. Christopher Ludwig. Anne Chazal also assisted with manuscript revisions. The authors are grateful to two anonymous reviewers and the following individuals who reviewed a draft copy of this paper: John F. Townsend, Steven M. Roble, and Joseph C. Mitchell.

Table 1. Flora of Virginia Army National Guard OMS No. 1 and No. 2 identified during DCR-DNH inventory, 2001. The list is arranged by major plant groups: Pteridophyta (ferns and fern allies), Gymnospermae (non-flowering seed plants), and Angiospermae (flowering plants). The Angiospermae are further divided into the Dicotyledoneae and Monocotyledoneae. Within each major group, families, genera, species, and subtaxa are arranged alphabetically. Nomenclature and common names follow Kartesz (1999) with the exception of *Setaria pumila* (Poir.) Roemer & J.A. Schultes ssp. *pumila*, where it appears that the Kartesz name, *Pennisetum glaucum* (L.) R. Br., is in error (A. Weakley, pers. comm.). Synonyms, shown following an equal sign (=), are provided for some taxa where Kartesz (1999) departs sharply from other familiar sources. Non-native taxa, as determined from a consensus of the standard regional floras, are preceded by an asterisk (*). Dates are listed as month-day-year. The last column shows the Allen Belden Jr. collection number for specimens deposited at VPI to voucher new Henrico County plant records.

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
PTERIDOPHYTA			
BLECHNACEAE			
Woodwardia areolata (L.) T. Moore	Netted chain fern	04-25-01	
DENNSTAEDTIACEAE			
Dennstaedtia punctilobula (Michx.) T. Moore	Eastern hay-scented fern	10-03-01	
Pteridium aquilinum (L.) Kuhn	Northern bracken fern	04-25-01	
DRYOPTERIDACEAE			
Athyrium filix-femina (L.) Roth ssp. *asplenioides* (Michx.) Hultén	Subarctic lady fern	05-23-01	
Onoclea sensibilis L.	Sensitive fern	05-23-01	
Polystichum acrostichoides (Michx.) Schott	Christmas fern	05-23-01	
LYCOPODIACEAE			
Lycopodium digitatum Dill. ex A. Braun	Fan ground-pine	05-23-01	
Lycopodium obscurum L.	Princess-pine	04-25-01	
OPHIOGLOSSACEAE			
Botrychium dissectum Spreng.	Cut-leaf grape fern	09-05-01	
OSMUNDACEAE			
Osmunda cinnamomea L.	Cinnamon fern	04-25-01	
Osmunda regalis L. var. *spectabilis* (Willd.) Gray	Royal fern	10-10-01	
THELYPTERIDACEAE			
Thelypteris noveboracensis (L.) Nieuwl.	New York fern	10-03-01	
GYMNOSPERMAE			
CUPRESSACEAE			
Juniperus virginiana L.	Eastern red-cedar	04-19-01	
PINACEAE			
Pinus taeda L.	Loblolly pine	04-25-01	
Pinus virginiana P. Mill.	Virginia pine	04-25-01	
ANGIOSPERMAE: DICOTYLEDONEAE			
ACERACEAE			
Acer rubrum L.	Red maple	04-25-01	
ANACARDIACEAE			
Rhus copallinum L. var. *latifolia* Engl.	Winged sumac	05-23-01	
Toxicodendron radicans (L.) Kuntze	Eastern poison-ivy	04-25-01	
APIACEAE			
Daucus carota L.	Queen Anne's lace	07-03-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
APOCYNACEAE			
Apocynum cannabinum L.	Indian-hemp	04-25-01	
Trachelospermum difforme (Walt.) Gray	Climbing-dogbane	07-03-01	
AQUIFOLIACEAE			
Ilex opaca Ait.	American holly	04-19-01	
Ilex verticillata (L.) Gray	Common winterberry	10-03-01	
ASCLEPIADACEAE			
Asclepias tuberosa L.	Butterfly milkweed	07-03-01	
ASTERACEAE			
**Achillea millefolium* L.	Common yarrow	04-25-01	
Ambrosia artemisiifolia L.	Annual ragweed	09-05-01	
Arnica acaulis (Walt.) B.S.P.	Common leopardbane	04-25-01	
Bidens aristosa (Michx.) Britt.	Bearded beggarticks	09-05-01	
= *Bidens polylepis* Blake			
Bidens bipinnata L.	Spanish-needles	10-10-01	
**Centaurea biebersteinii* DC.	Spotted knapweed	07-03-01	
= *Centaurea maculosa* auct. non Lam.			
**Centaurea cyanus* L.	Garden cornflower	05-23-01	
Conyza canadensis (L.) Cronq.	Canadian horseweed	09-05-01	
= *Erigeron canadensis* L.			
Coreopsis verticillata L.	Whorled tickseed	04-25-01	
Elephantopus carolinianus Raeusch.	Carolina elephant's-foot	10-03-01	
Erechtites hieraciifolia (L.) Raf. ex DC.	American burnweed	09-05-01	
Erigeron annuus (L.) Pers.	Eastern daisy fleabane	07-03-01	
Erigeron strigosus Muhl. ex Willd.	Prairie fleabane	07-03-01	
Eupatorium capillifolium (Lam.)	Small dog-fennel	04-25-01	
Eupatorium dubium Willd. ex Poir.	Coastal-Plain Joe-Pye-weed	07-03-01	
Eupatorium hyssopifolium L. var. *hyssopifolium*	Hyssop-leaf thoroughwort	10-10-01	
Eupatorium hyssopifolium L. var. *laciniatum* Gray	Hyssop-leaf thoroughwort	07-03-01	
Eupatorium perfoliatum L.	Common boneset	05-23-01	
Eupatorium pilosum Walt.	Rough boneset	07-03-01	
Eupatorium rotundifolium L. var. *ovatum* (Bigelow) Torr.	Round-leaf thoroughwort	05-23-01	
=*Eupatorium pubescens* Muhl. ex Willd.			
Eurybia compacta Nesom	Savannah wood-aster	09-05-01	
= *Aster gracilis* Nutt.			
Euthamia caroliniana (L.) Greene ex Porter & Britt.	Slender goldentop	09-05-01	
= *Solidago tenuifolia* Pursh			
Euthamia graminifolia (L.) Greene	Flat-top goldentop	09-05-01	
= *Solidago graminifolia* (L.) Salisb.			
Gamochaeta purpurea (L.) Cabrera	Spoon-leaf purple everlasting	04-25-01	
= *Gnaphalium purpureum* L.			
Helenium flexuosum Raf.	Purple-head sneezeweed	07-03-01	
Hieracium gronovii L.	Queendevil	09-05-01	
**Hypochaeris radicata* L.	Hairy cat's-ear	04-25-01	
Krigia virginica (L.) Willd.	Virginia dwarf-dandelion	04-19-01	
Lactuca canadensis L.	Florida blue lettuce	07-03-01	
**Leucanthemum vulgare* Lam.	Oxy-eye daisy	04-25-01	
= *Chrysanthemum leucanthemum* L.			
Mikania scandens (L.) Willd.	Climbing hempvine	05-23-01	
Packera anonyma (Wood) W.A. Weber & A. Löve	Small's groundsel	04-25-01	
= *Senecio anonymus* Wood			
Pluchea camphorata (L.) DC.	Plowman's-wort	09-05-01	
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt	Blunt-leaf rabbit-tobacco	09-05-01	
= *Gnaphalium obtusifolium* L.			
Pyrrhopappus carolinianus (Walt.) DC.	Carolina desert-chicory	07-03-01	
Sericocarpus linifolius (L.) B.S.P.	Narrow-leaf white-top-aster	07-03-01	
= *Aster solidagineus* Michx.			
Solidago altissima L.	Tall goldenrod	09-05-01	
Solidago nemoralis Ait.	Gray goldenrod	09-05-01	
Solidago pinetorum Small	Small's goldenrod	07-03-01	
Solidago puberula Nutt. var. *pulverulenta*	Downy goldenrod	09-05-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
ASTERACEAE (continued)			
Solidago rugosa P. Mill.	Wrinkle-leaf goldenrod	09-05-01	
Symphyotrichum grandiflorum (L.) Nesom = *Aster grandiflorus* L.	Large-flower American-aster	10-10-01	
Symphyotrichum lanceolatum (Willd.) Nesom = *Aster lanceolatus* Willd.	White panicled American-aster	10-03-01	
Symphyotrichum lateriflorum (L.) A.& D. Löve = *Aster lateriflorus* (L.) Britt.	Farewell-summer	10-10-01	
Symphyotrichum pilosum (Willd.) Nesom = *Aster pilosus* Willd.	White oldfield American-aster	10-03-01	
**Taraxacum officinale* G.H. Weber ex Wiggers	Common dandelion	04-19-01	
Vernonia noveboracensis (L.) Michx.	New York ironweed	10-03-01	
BETULACEAE			
Betula nigra L.	River birch	04-25-01	
BIGNONIACEAE			
Campsis radicans (L.) Seem. ex Bureau	Trumpet-creeper	04-25-01	
BORAGINACEAE			
Myosotis verna Nutt.	Spring forget-me-not	04-25-01	
BRASSICACEAE			
**Arabidopsis thaliana* (L.) Heynh.	Thalecress	04-25-01	
**Barbarea vulgaris* Ait. f.	Garden yellow-rocket	04-19-01	
**Cardamine hirsuta* L.	Hairy bittercress	04-25-01	
Draba brachycarpa Nutt. ex Torr. & Gray	Short-pod whitlow-grass	04-25-01	
Lepidium virginicum L.	Poorman's-pepperwort	04-25-01	
**Microthlaspi perfoliatum* (L.) F.K. Mey. = *Thlaspi perfoliatum* L.	Pennycress	04-19-01	
**Teesdalia nudicaulis* (L.) Ait. f.	Common shepherd's-cress	04-25-01	
**Thlaspi alliaceum* L.	Roadside Pennycress	04-19-01	AB 1896
CAMPANULACEAE			
Lobelia inflata L.	Indian-tobacco	09-05-01	
Lobelia nuttallii J.A. Schultes	Nuttall's lobelia	07-03-01	
Triodanis perfoliata (L.) Nieuwl. = *Specularia perfoliata* (L.) A. DC.	Clasping-leaf Venus'-looking-glass	05-23-01	
CAPRIFOLIACEAE			
**Lonicera japonica* Thunb.	Japanese honeysuckle	04-19-01	
Sambucus nigra ssp. *canadensis* (L.) R. Bolli = *Sambucus canadensis* L.	Black elder	10-03-01	
Viburnum dentatum L.	Southern arrow-wood	05-23-01	
Viburnum nudum L.	Possumhaw	04-19-01	
CARYOPHYLLACEAE			
**Cerastium dubium* (Bast.) Guépin	Doubtful mouse-ear chickweed	04-19-01	AB 1899 **State record**
**Scleranthus annuus* L.	Annual knawel	04-25-01	
**Stellaria media* (L.) Vill.	Common chickweed	04-19-01	
CISTACEAE			
Lechea minor L.	Thyme-leaf pinweed	09-05-01	
CLETHRACEAE			
Clethra alnifolia L.	Coastal sweet-pepperbush	04-19-01	
CLUSIACEAE			
Hypericum canadense L.	Lesser Canadian St. John's-wort	07-03-01	
Hypericum gentianoides (L.) B.S.P.	Orange-grass	04-25-01	
Hypericum hypericoides (L.) Crantz ssp. *hypericoides*	St. Andrew's-cross	05-23-01	
Hypericum hypericoides (L.) Crantz ssp. *multicaule* (Michx. ex Willd.) Robson = *Hypericum stragulum* P. Adams & Robson	St. Andrew's-cross	04-25-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
CLUSIACEAE (continued)			
Hypericum mutilum L.	Dwarf St. John's-wort	07-03-01	
Hypericum perforatum L.	Common St. John's-wort	05-23-01	
Hypericum punctatum Lam.	Spotted St. John's-wort	07-03-01	
CONVOLVULACEAE			
Ipomoea pandurata (L.) G.F.W. Mey.	Man-of-the-earth	09-05-01	
CORNACEAE			
Cornus florida L.	Flowering dogwood	04-19-01	
Nyssa sylvatica Marsh.	Black tupelo	04-25-01	
EBENACEAE			
Diospyros virginiana L.	Common persimmon	10-03-01	
ERICACEAE			
Gaylussacia baccata (Wangenh.) K. Koch	Black huckleberry	04-25-01	
Gaylussacia frondosa (L.) Torr. & Gray ex Torr.	Blue huckleberry	04-25-01	
Leucothoe racemosa (L.) Gray	Swamp doghobble	04-19-01	
Lyonia mariana (L.) D. Don	Piedmont Staggerbush	05-23-01	
Rhododendron atlanticum (Ashe) Rehd.	Dwarf azalea	04-25-01	
Vaccinium formosum Andr.	Southern blueberry	04-19-01	
Vaccinium fuscatum Ait.	Black blueberry	04-19-01	
Vaccinium pallidum Ait.	Early lowbush blueberry	04-19-01	
Vaccinium stamineum L.	Deerberry	04-19-01	
EUPHORBIACEAE			
Acalypha gracilens Gray	Slender three-seed-mercury	10-03-01	
Acalypha rhomboidea Raf.	Common three-seed-mercury	09-05-01	
Chamaesyce maculata (L.) = *Euphorbia maculata* L.	Small spotted sandmat	07-03-01	
Chamaesyce nutans (Lag.) Small = *Euphorbia nutans* Lag.	Eyebane	09-05-01	
FABACEAE			
**Albizia julibrissin* Durazz.	Silktree	05-23-01	
Apios americana Medik.	Groundnut	07-03-01	
Chamaecrista fasciculata (Michx.) Greene = *Cassia fasciculata* Michx.	Sleepingplant	07-03-01	
Chamaecrista nictitans (L.) Moench = *Cassia nictitans* L.	Partridge-pea	09-05-01	
Desmodium glabellum (Michx.) DC.	Dillenius' tick-trefoil	09-05-01	
Desmodium paniculatum (L.) DC.	Panicled-leaf tick-trefoil	09-05-01	
**Kummerowia stipulacea* (Maxim.) Makino = *Lespedeza stipulacea* Maxim.	Korean-clover	09-05-01	
**Kummerowia striata* (Thunb.) Schindl. = *Lespedeza striata* (Thunb.) Hook . & Arn.	Japanese-clover	07-03-01	AB 1943
**Lespedeza cuneata* (Dum.-Cours.) G. Don	Chinese bush-clover	04-25-01	
Lespedeza procumbens Michx.	Trailing bush-clover	09-05-01	
Lespedeza repens (L.) W. Bart.	Creeping bush-clover	09-05-01	
Lespedeza virginica (L.) Britt.	Slender bush-clover	09-05-01	
**Melilotus officinalis* (L.) Lam.	Yellow sweet-clover	05-23-01	
Stylosanthes biflora (L.) B.S.P.	Side-beak pencil-flower	09-05-01	
Tephrosia virginiana (L.) Pers.	Goat's-rue	07-03-01	
**Trifolium arvense* L.	Rabbit-foot clover	07-03-01	
**Trifolium campestre* Schreb.	Lesser hop clover	05-23-01	
**Trifolium dubium* Sibthorp	Suckling clover	04-25-01	
**Trifolium pratense* L.	Red clover	09-05-01	
**Trifolium repens* L.	White clover	04-25-01	
**Vicia lathyroides* L.	Spring vetch	04-25-01	
**Vicia sativa* L.	Garden vetch	04-25-01	

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FAGACEAE			
Castanea pumila (L.) P. Mill.	Allegheny-chinkapin	05-23-01	
Quercus alba L.	Northern white oak	04-25-01	
Quercus coccinea Muenchh.	Scarlet oak	10-03-01	
Quercus falcata Michx.	Southern red oak	04-25-01	
Quercus nigra L.	Water oak	04-25-01	
Quercus phellos L.	Willow oak	04-25-01	
Quercus rubra L.	Northern red oak	04-25-01	
Quercus stellata Wangenh.	Post oak	10-10-01	
Quercus velutina Lam.	Black oak	05-23-01	
GENTIANACEAE			
Gentiana saponaria L.	Harvestbells	10-03-01	
GERANIACEAE			
**Geranium dissectum* L.	Cut-leaf crane's-bill	05-23-01	AB 1903
GROSSULARIACEAE			
Itea virginica L.	Virginia sweetspire	05-23-01	
HAMAMELIDACEAE			
Liquidambar styraciflua L.	Sweet-gum	04-19-01	
LAMIACEAE			
**Lamium purpureum* L.	Red henbit	04-25-01	
Lycopus virginicus L.	Virginia water-horehound	09-05-01	
**Prunella vulgaris* L.	Common selfheal	09-05-01	
Scutellaria integrifolia L.	Helmet-flower	05-23-01	
LAURACEAE			
Sassafras albidum (Nutt.) Nees	Sassafras	04-19-01	
LINACEAE			
Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern.	Stiff yellow flax	07-03-01	
MAGNOLIACEAE			
Magnolia virginiana L.	Sweet-bay	04-19-01	
MELASTOMATACEAE			
Rhexia mariana L.	Maryland meadow-beauty	07-03-01	
Rhexia virginica L.	Handsome-Harry	07-03-01	
OLEACEAE			
**Ligustrum sinense* Lour.	Chinese privet	10-03-01	
ONAGRACEAE			
Ludwigia alternifolia L.	Seedbox	07-03-01	
Ludwigia palustris (L.) Ell.	Marsh primrose-willow	07-03-01	
OXALIDACEAE			
**Oxalis corniculata* L.	Creeping yellow wood-sorrel	05-23-01	
Oxalis dillenii Jacq.	Slender yellow wood-sorrel	05-23-01	
PHYTOLACCACEAE			
Phytolacca americana L.	American pokeweed	07-03-01	
PLANTAGINACEAE			
Plantago aristata Michx.	Large-bract plantain	07-03-01	
**Plantago lanceolata* L.	English plantain	04-25-01	
Plantago virginica L.	Pale-seed plantain	04-25-01	
POLYGALACEAE			
Polygala curtissii Gray	Curtiss' milkwort	10-03-01	

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POLYGONACEAE			
**Polygonum caespitosum* Blume var. *longisetum* (de Bruyn) A.N. Steward	Oriental lady's-thumb	09-05-01	
Polygonum hydropiperoides Michx.	Swamp smartweed	10-30-01	
Polygonum pensylvanicum L.	Pinkweed	10-10-01	
Polygonum punctatum Ell.	Dotted smartweed	10-03-01	
**Rumex acetosella* L.	Common sheep sorrel	04-25-01	
**Rumex crispus* L.	Curly dock	04-25-01	
**Rumex obtusifolius* L.	Bitter dock	05-23-01	
PRIMULACEAE			
**Anagallis arvensis* L.	Scarlet pimpernel	09-05-01	
Lysimachia quadrifolia L.	Whorled yellow-loosestrife	05-23-01	
PYROLACEAE			
Chimaphila maculata (L.) Pursh	Striped prince's-pine	04-19-01	
RANUNCULACEAE			
Clematis virginiana L.	Devil's-darning-needles	05-23-01	
Ranunculus bulbosus L.	St. Anthony's-turnip	04-25-01	
ROSACEAE			
Amelanchier canadensis (L.) Medik.	Canadian service-berry	04-19-01	
Duchesnea indica (Andr.) Focke	Indian-strawberry	04-25-01	
Photinia pyrifolia (Lam.) Robertson & Phipps = *Aronia arbutifolia* (L.) Pers. = *Pyrus arbutifolia* (L.) L. f.	Red chokeberry	04-19-01	
Potentilla canadensis L.	Dwarf cinquefoil	04-25-01	
Potentilla simplex Michx.	Oldfield cinquefoil	04-25-01	
Prunus serotina Ehrh.	Black cherry	04-25-01	
Rubus argutus Link	Saw-tooth blackberry	05-23-01	
Rubus cuneifolius Pursh	Sand blackberry	07-03-01	
Rubus flagellaris Willd.	Whiplash dewberry	07-03-01	
Rubus scambens Bailey	Springtime dewberry	10-03-01	
RUBIACEAE			
Cephalanthus occidentalis L.	Common buttonbush	10-10-01	
Diodia teres Walt.	Poorjoe	04-25-01	
Houstonia caerulea L. = *Hedyotis caerulea* (L.) Hook.	Quaker-ladies	04-25-01	
Houstonia pusilla Schoepf = *Hedyotis crassifolia* Raf.	Tiny bluet	04-25-01	AB 1897
Mitchella repens L.	Partridge-berry	04-19-01	
SALICACEAE			
Populus grandidentata Michx.	Big-tooth aspen	05-23-01	
Salix humilis Marsh.	Prairie willow	04-19-01	
Salix nigra Marsh.	Black willow	04-25-01	
SCROPHULARIACEAE			
Agalinis purpurea (L.)	Pennell purple false foxglove	10-03-01	
Nuttallanthus canadensis (L.) D.A. Sutton = *Linaria canadensis* (L.) Chaz.	Oldfield-toadflax	04-25-01	
**Veronica arvensis* L.	Corn speedwell	04-25-01	
**Veronica hederifolia* L.	Ivy-leaf speedwell	04-25-01	
Veronica officinalis L.	Common gypsyweed	04-25-01	
Veronica peregrina L.	Neckweed	04-25-01	
**Veronica persica* Poir.	Bird-eye speedwell	04-25-01	
SOLANACEAE			
Solanum carolinense L.	Carolina horse-nettle	07-03-01	
TYPHACEAE			
Typha latifolia L.	Broad-leaf cat-tail	09-05-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
URTICACEAE			
Boehmeria cylindrica (L.) Sw.	Small-spike false nettle	10-03-01	
VALERIANACEAE			
**Valerianella locusta* (L.) Lat.	Lamb's-lettuce	04-25-01	
VIOLACEAE			
**Viola arvensis* Murr.	European field pansy	04-25-01	
Viola bicolor Pursh	Field pansy	04-19-01	
Viola cucullata Ait.	Marsh blue violet	04-19-01	
Viola × *primulifolia* L. (pro sp.) [*lanceolata* × *macloskeyi*] = *Viola primulifolia* L.	Primrose-leaved violet	04-19-01	
VITACEAE			
Parthenocissus quinquefolia (L.)Planch.	Virginia-creeper	04-19-01	
Vitis cinerea (Engelm.) Millard var. *floridana* Munson	Gray-bark grape	10-03-01	AB 1937
Vitis rotundifolia Michx.	Muscadine	04-25-01	
ANGIOSPERMAE: MONOCOTYLEDONEAE			
COMMELINACEAE			
**Commelina communis* L.	Asiatic dayflower	09-05-01	
**Murdannia keisak* (Hassk.) Hand.-Maz.	Wart-removing-herb	05-23-01	
CYPERACEAE			
Carex alata Torr.	Broad-wing sedge	05-23-01	
Carex albicans Willd. ex Spreng.	White-tinge sedge	05-23-01	
Carex blanda Dewey	Eastern woodland sedge	05-23-01	
Carex bullata Schkuhr ex Willd.	Button sedge	05-23-01	
Carex crinita Lam.	Fringed sedge	05-23-01	
Carex debilis Michx.	White-edge sedge	05-23-01	
Carex frankii Kunth	Frank's Sedge	07-03-01	
Carex hirsutella Mackenzie = *Carex complanata* Torr. & Hook. var. *hirsuta* (Willd.) Gleason	Fuzzy-wuzzy sedge	05-23-01	
Carex intumescens Rudge	Greater bladder sedge	05-23-01	
Carex joorii Bailey	Cypress-swamp sedge	10-10-01	
Carex lonchocarpa Willd. = *Carex folliculata* L. var. *australis* Bailey	Southern long sedge	05-23-01	
Carex longii Mackenzie	Long's sedge	05-23-01	
Carex louisianica Bailey	Louisiana sedge	10-10-01	
Carex lurida Wahlenb.	Sallow sedge	05-23-01	
Carex scoparia Schkuhr ex Willd.	Pointed broom sedge	05-23-01	
Carex seorsa Howe	Weak stellate sedge	05-23-01	
Carex vulpinoidea Michx.	Common fox sedge	05-23-01	
Cyperus echinatus (L.) Wood = *Cyperus ovularis* (Michx.) Torr.	Globe flat sedge	07-03-01	
**Cyperus iria* L.	Ricefield flat sedge	09-05-01	
Cyperus pseudovegetus Steud.	Marsh flat sedge	07-03-01	
Cyperus strigosus L.	Straw-color flat sedge	09-05-01	
Eleocharis obtusa (Willd.) J.A. Schultes = *Eleocharis ovata* (Roth) Roemer & J. A. Schultes var. *obtusa* (Willd.) Kükenth.	Blunt spike-rush	09-05-01	
Eleocharis tenuis (Willd.) J.A. Schultes	Slender spike-rush	05-23-01	
Eleocharis tuberculosa (Michx.) Roemer & J.A. Schultes	Cone-cup spike-rush	10-03-01	
**Fimbristylis annua* (All.) Roemer & J.A. Schultes	Annual fimbry	09-05-01	
Fimbristylis autumnalis (L.) Roemer & J.A. Schultes	Slender fimbry	09-05-01	
Rhynchospora capitellata (Michx.) Vahl	Brownish beak sedge	09-05-01	
Rhynchospora corniculata (Lam.) Gray	Short-bristle horned beak sedge	10-03-01	AB 1932
Rhynchospora glomerata (L.) Vahl	Clustered beak sedge	10-03-01	AB 1942
Rhynchospora inexpansa (Michx.) Vahl	Nodding beak sedge	07-03-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
CYPERACEAE (continued)			
Rhynchospora recognita (Gale) Kral = *Rhynchospora globularis* (Chapman) Small var. *recognita* Gale	Coarse globe beak sedge	10-10-01	
Scirpus cyperinus (L.) Kunth	Cottongrass bulrush	09-05-01	
Scirpus georgianus Harper	Georgia bulrush	07-03-01	
IRIDACEAE			
Sisyrinchium angustifolium P. Mill.	Narrow-leaf blue-eyed-grass	05-23-01	
JUNCACEAE			
Juncus acuminatus Michx.	Knotty-leaf rush	07-03-01	
Juncus canadensis J. Gay ex Laharpe	Canadian rush	09-05-01	
Juncus dichotomus Ell.	Forked rush	07-03-01	AB 1910
Juncus effusus L.	Lamp rush	07-03-01	
Juncus marginatus Rostk.	Grass-leaf rush	07-03-01	
Juncus scirpoides Lam.	Needle-pod rush	10-10-01	
Luzula bulbosa (Wood) Smyth & Smyth	Bulbous wood-rush	04-25-01	
LILIACEAE			
Allium canadense L.	Meadow garlic	07-03-01	
**Allium vineale* L.	Crow garlic	04-25-01	
**Narcissus* sp.	Narcissus	04-25-01	
Polygonatum biflorum (Walt.) Ell. var. *commutatum* (J.A. & J.H. Schultes) Morong	King Solomon'-seal	10-10-01	
ORCHIDACEAE			
Cypripedium acaule Ait.	Pink lady's-slipper	04-25-01	
POACEAE			
Agrostis elliottiana J.A. Schultes	Elliott's bent	05-23-01	AB 1902
Agrostis hyemalis (Walt.) B.S.P.	Winter bent	05-23-01	
Agrostis perennans (Walt.) Tuckerman	Upland bent	09-05-01	
**Aira caryophyllea* L	Common silver-hair grass	04-25-01	
Andropogon glomeratus (Walt.) B.S.P.	Bushy bluestem	04-25-01	
Andropogon ternarius Michx.	Split-beard bluestem	10-03-01	
Andropogon virginicus L.	Broom-sedge	04-19-01	
**Anthoxanthum odoratum* L.	Large sweet vernal grass	04-19-01	
Aristida dichotoma Michx.	Church-mouse three-awn	10-03-01	
Aristida oligantha Michx.	Prairie three-awn	09-05-01	
**Bromus commutatus* Schrad.	Meadow brome	07-03-01	
Calamagrostis coarctata (Torr.) Eat. = *Calamagrostis cinnoides* W. Bart. nom. super.	Nuttall's reed grass	10-03-01	
Chasmanthium laxum (L.) Yates	Slender wood-oats	05-23-01	
Cinna arundinacea L.	Sweet wood-reed	10-03-01	
**Cynodon dactylon* (L.) Pers	Bermuda grass	07-03-01	
**Dactylis glomerata* L.	Orchard grass	04-25-01	
Danthonia sericea Nutt.	Silky wild oat grass	05-23-01	
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	Poverty wild oat grass	04-25-01	
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark	Needle-leaf rosette grass	05-23-01	
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark	Tapered rosette grass	05-23-01	
Dichanthelium clandestinum (L.) Gould	Deer-tongue rosette grass	05-23-01	
Dichanthelium depauperatum (Muhl.) Gould	Starved rosette grass	05-23-01	
Dichanthelium dichotomum (L.) Gould	Cypress rosette grass	05-23-01	
Dichanthelium laxiflorum (Lam.) Gould	Open-flower rosette grass	05-23-01	
Dichanthelium scoparium (Lam.) Gould	Broom rosette grass	05-23-01	
**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.	Smooth crab grass	10-03-01	
**Digitaria sanguinalis* (L.) Scop.	Hairy crab grass	09-05-01	
Echinochloa muricata (Beauv.) Fern.	Rough barnyard grass	09-05-01	
Elymus virginicus L.	Virginia wild rye	09-05-01	
**Eragrostis pilosa* (L.) Beauv.	Indian love grass	09-05-01	
Eragrostis spectabilis (Pursh) Steud.	Petticoat-climber	09-05-01	
Glyceria striata (Lam.) A.S. Hitchc.	Fowl manna grass	05-23-01	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	COUNTY RECORD COLLECTION NO.
POACEAE (continued)			
Hordeum pusillum Nutt.	Little barley	05-23-01	
Leersia oryzoides (L.) Sw.	Rice cut grass	10-03-01	
Leersia virginica Willd.	White grass	09-05-01	
**Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot =*Lolium multiflorum* Lam.	Perennial rye grass	05-23-01	
**Lolium pratense* (Huds.) S.J. Darbyshire = *Festuca elatior* L. p.p. = *Festuca pratensis* Huds.	Meadow rye grass	05-23-01	
**Microstegium vimineum* (Trin.) A. Camus	Nepalese browntop	09-05-01	
Panicum anceps Michx.	Beaked panic grass	09-05-01	
Panicum dichotomiflorum Michx.	Fall panic grass	09-05-01	
Panicum rigidulum var. *pubescens* (Vasey) Lelong = *Panicum longifolium* Torr.	Red-top panic grass	09-05-01	
Panicum verrucosum Muhl.	Warty panic grass	09-05-01	
**Paspalum dilatatum* Poir.	Golden crown grass	07-03-01	
Paspalum floridanum Michx.	Florida crown grass	09-05-01	AB 1941
Paspalum setaceum Michx.	Slender crown grass	07-03-01	
**Poa annua* L.	Annual blue grass	04-25-01	
**Poa compressa* L.	Flat-stem blue grass	05-23-01	
Poa pratensis L.	Kentucky blue grass	05-23-01	
Saccharum alopecuroidum (L.) Nutt. = *Erianthus alopecuroides* (L.) Ell.	Silver plume grass	10-10-01	AB 1939
Saccharum baldwinii Spreng. = *Erianthus strictus* Ell.	Narrow plume grass	10-03-01	AB 1938
Setaria parviflora (Poir.) Kerguélen = *Setaria geniculata* auct. non (Wild.) Beauv.	Marsh bristle grass	09-05-01	
Setaria pumila (Poir.) Roemer & J.A. Schultes ssp. *pumila* = *Setaria glauca* (L.) Beauv. [Kartesz (1999) lists this taxon as *Pennisetum glaucum* (L.) R. Br.]	Pearl-millet	10-03-01	
Sorghastrum nutans (L.) Nash	Yellow Indian grass	10-10-01	
Tridens flavus (L.) A.S. Hitchc.	Tall redtop	04-25-01	
**Vulpia myuros* (L.) K.C. Gmel. = *Festuca myuros* L.	Rat-tail six-weeks grass	05-23-01	
SMILACACEAE			
Smilax glauca Walt.	Sawbrier	04-25-01	
Smilax rotundifolia L.	Horsebrier	04-25-01	

Table 2. Fauna of Virginia Army National Guard OMS No. 1 and No. 2 identified during DCR-DNH inventory, 2001-2002. The list is arranged by major groups: vertebrates followed by invertebrates. Families, genera, and species are arranged alphabetically. Taxa preceded by a [c] were collected; all others were identified by sight or sound in the field. Taxa followed by an asterisk (*) are potential county records (Carle, 1982; Opler et al., 1995). Dates are listed as month-day-year. See the Methods section for a key to the abbreviations for method of inventory. Nomenclature and identification sources included the following: American Ornithologists' Union (1998), Conant & Collins (1998), Covell (1984), Crother (2000), Dragonfly Society of the Americas (1996), Dunkle (2000), Glassberg (1999), Jenkins & Burkhead (1994), Kain (1987), Knisley & Schultz (1997), Linzey (1998), Miller (1992), Opler (1998), Page & Burr (1991), Peterson (1980), and Westfall & May (1996). Note that there is no standard list of common names for moths.

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
FISH			
CENTRARCHIDAE			
[c] *Acantharchus pomotis* (Baird)	Mud Sunfish	06-21-01	MN
[c] *Enneacanthus gloriosus* (Holbrook)	Bluespotted Sunfish	06-21-01	MN
UMBRIDAE			
[c] *Umbra pygmaea* (DeKay)	Eastern Mudminnow	06-21-01	MN
AMPHIBIANS			
BUFONIDAE			
[c] *Bufo americanus* Holbrook	American Toad	08-13-01	HV
[c] *Bufo fowleri* (Hinckley)	Fowler's Toad	06-18-01	HV
HYLIDAE			
[c] *Acris crepitans* Baird	Northern Cricket Frog	06-29-01	HV
[c] *Hyla chrysoscelis* Cope	Cope's Gray Treefrog	07-11-01	DF
Hyla cinerea (Schneider)	Green Treefrog	08-14-01	HV
[c] *Pseudacris crucifer* (Wied-Neuwied)	Spring Peeper	09-20-01	DF
MICROHYLIDAE			
[c] *Gastrophryne carolinensis* (Holbrook)	Eastern Narrowmouth Toad	06-19-01	DF
RANIDAE			
Rana clamitans Latreille	Green Frog	04-19-01	HV
Rana palustris LeConte	Pickerel Frog	08-01-01	HV
REPTILES			
CHELYDRIDAE			
Chelydra serpentina (Linnaeus)	Snapping Turtle	06-21-01	MN
COLUBRIDAE			
Elaphe obsoleta (Say)	Rat Snake	07-03-01	HV
Heterodon platirhinos Latreille	Eastern Hognose Snake	08-01-01	HV
EMYDIDAE			
Clemmys guttata (Schneider)	Spotted Turtle	08-14-01	HV
Terrapene carolina (Linnaeus)	Eastern Box Turtle	06-29-01	HV
KINOSTERNIDAE			
Kinosternon subrubrum (Lacepède)	Eastern Mud Turtle	08-14-01	HV
PHRYNOSOMATIDAE			
Sceloporus undulatus (Bosc & Daudin)	Eastern Fence Lizard	08-01-01	HV
SCINCIDAE			
Eumeces inexpectatus Taylor	Southeastern Five-lined Skink	04-15-02	CB
BIRDS			
ACCIPITRIDAE			
Buteo jamaicensis (Gmelin)	Red-tailed Hawk	06-29-01	HV
APODIDAE			
Chaetura pelagica (Linnaeus)	Chimney Swift	05-31-01	BD

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
BIRDS (continued)			
BOMBYCILLIDAE			
Bombycilla cedrorum Vieillot	Cedar Waxwing	04-19-01	HV
CARDINALIDAE			
Cardinalis cardinalis (Linnaeus)	Northern Cardinal	05-31-01	BD
Passerina cyanea (Linnaeus)	Indigo Bunting	05-31-01	BD
CATHARTIDAE			
Cathartes aura (Linnaeus)	Turkey Vulture	04-19-01	HV
COLUMBIDAE			
Zenaida macroura (Linnaeus)	Mourning Dove	05-31-01	BD
CORVIDAE			
Cyanocitta cristata (Linnaeus)	Blue Jay	05-31-01	BD
CUCULIDAE			
Coccyzus americanus (Linnaeus)	Yellow-billed Cuckoo	06-29-01	BD
EMBERIZIDAE			
Pipilo erythrophthalmus (Linnaeus)	Eastern Towhee	05-31-01	BD
Spizella passerina (Bechstein)	Chipping Sparrow	05-31-01	BD
FRINGILLIDAE			
Carduelis tristis (Linnaeus)	American Goldfinch	05-31-01	BD
ICTERIDAE			
Euphagus carolinus (Muller)	Rusty Blackbird	04-15-02	BD
Molothrus ater (Boddaert)	Brown-headed Cowbird	05-31-01	BD
MIMIDAE			
Dumetella carolinensis (Linnaeus)	Gray Catbird	08-01-01	BD
Mimus polyglottos (Linnaeus)	Northern Mockingbird	05-31-01	BD
Toxostoma rufum (Linnaeus)	Brown Thrasher	04-19-01	BD
PARIDAE			
Poecile carolinensis (Audubon)	Carolina Chickadee	05-31-01	BD
Baeolophus bicolor (Linnaeus)	Tufted Titmouse	05-31-01	BD
PARULIDAE			
Dendroica caerulescens (Gmelin)	Black-throated Blue Warbler	10-23-01	HV
Dendroica coronata (Linnaeus)	Yellow-rumped Warbler	04-15-02	HV
Dendroica discolor (Vieillot)	Prairie Warbler	04-19-01	HV
Dendroica pinus (Wilson)	Pine Warbler	05-31-01	BD
Geothlypis trichas (Linnaeus)	Common Yellowthroat	04-19-01	HV
Mniotilta varia (Linnaeus)	Black-and-white Warbler	05-31-01	BD
Oporornis formosus (Wilson)	Kentucky Warbler	09-06-01	HV
Protonotaria citrea (Boddaert)	Prothonotary Warbler	09-06-01	HV
Seiurus aurocapillus (Linnaeus)	Ovenbird	05-31-01	BD
Wilsonia citrina (Boddaert)	Hooded Warbler	05-31-01	BD
PICIDAE			
Colaptes auratus (Linnaeus)	Northern Flicker	05-31-01	BD
Dryocopus pileatus (Linnaeus)	Pileated Woodpecker	09-18-01	HV
Melanerpes carolinus (Linnaeus)	Red-bellied Woodpecker	05-31-01	BD
Picoides pubescens (Linnaeus)	Downy Woodpecker	08-01-01	HV
Picoides villosus (Linnaeus)	Hairy Woodpecker	09-06-01	HV
REGULIDAE			
Regulus calendula (Linnaeus)	Ruby-crowned Kinglet	04-19-01	HV
Regulus satrapa Lichtenstein	Golden-crowned Kinglet	06-29-01	HV

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
BIRDS (continued)			
SITTIDAE			
Sitta carolinensis Latham	White-breasted Nuthatch	05-31-01	BD
STURNIDAE			
Sturnus vulgaris Linnaeus	European Starling	05-31-01	BD
SYLVIIDAE			
Polioptila caerulea (Linnaeus)	Blue-gray Gnatcatcher	05-31-01	BD
THRAUPIDAE			
Piranga rubra (Linnaeus)	Summer Tanager	05-31-01	BD
TROGLODYTIDAE			
Thryothorus ludovicianus (Latham)	Carolina Wren	05-31-01	BD
TURDIDAE			
Hylocichla mustelina (Gmelin)	Wood Thrush	05-31-01	BD
Sialia sialis (Linnaeus)	Eastern Bluebird	05-31-01	BD
Turdus migratorius Linnaeus	American Robin	05-31-01	BD
TYRANNIDAE			
Contopus virens (Linnaeus)	Eastern Wood-pewee	05-31-01	BD
Myiarchus crinitus (Linnaeus)	Great Crested Flycatcher	05-31-01	BD
Sayornis phoebe (Latham)	Eastern Phoebe	05-31-01	BD
Tyrannus tyrannus (Linnaeus)	Eastern Kingbird	05-31-01	BD
VIREONIDAE			
Vireo olivaceus (Linnaeus)	Red-eyed Vireo	05-31-01	BD
MAMMALS			
CERVIDAE			
Odocoileus virginianus (Zimmermann)	White-tailed Deer	05-31-01	HV
MURIDAE			
Peromyscus leucopus (Rafinesque)	White-footed Mouse	06-19-01	SH
PROCYONIDAE			
Procyon lotor (Linnaeus)	Raccoon	05-31-01	HV
SCIURIDAE			
Sciurus carolinensis Gmelin	Gray Squirrel	05-31-01	HV
Tamias striatus (Linnaeus)	Eastern Chipmunk	05-31-01	HV
VESPERTILIONIDAE			
Lasiurus borealis (Muller)	Red Bat	08-14-01	MT
COLEOPTERA (BEETLES)			
CICINDELIDAE			
[c] *Cicindela rufiventris* Dejean	A tiger beetle	08-01-01	SW
[c] *Cicindela sexguttata* Fabricius	A tiger beetle	04-19-01	SW
LEPIDOPTERA (BUTTERFLIES, SKIPPERS, and MOTHS)			
ARCTIIDAE			
[c] *Cisseps fulvicollis* (Hübner)		05-31-01	UV
[c] *Cisthene plumbea* Stretch		08-15-01	UV
[c] *Clemensia albata* Packard		09-07-01	UV
[c] *Crambidia uniformis* Dyar		09-20-01	UV
[c] *Grammia parthenice intermedia* (Stretch)		09-19-01	UV
[c] *Grammia phyllira* (Drury)		09-20-01	UV
[c] *Haploa clymene* (Brown)		07-11-01	UV
[c] *Hypoprepia fucosa* Hübner		08-15-01	UV
[c] *Pyrrharctia Isabella* (J. E. Smith)		08-15-01	UV
[c] *Spilosoma congrua* Walker		05-16-01	UV

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
LEPIDOPTERA (continued)			
DREPANIDAE			
[c] *Oreta rosea* (Walker)		05-31-01	UV
GEOMETRIDAE			
[c] *Anacamptodes vellivolata* (Hulst)		05-16-01	UV
[c] *Besma quercivoraria* (Guenée)		05-16-01	UV
[c] *Campaea perlata* (Guenée)		05-16-01	UV
[c] *Costaconvexa centrostrigaria* (Wollaston)		08-15-01	UV
[c] *Cyclophora pendulinaria* (Guenée)		08-14-01	UV
[c] *Euchlaena obtusaria* (Hübner)		05-16-01	UV
[c] *Eusarca confusaria* Hübner		05-31-01	UV
[c] *Glena cribrataria* (Guenée)		05-16-01	UV
[c] *Hypagyrtis esther* (Barnes)		08-15-01	UV
[c] *Hypagyrtis unipunctata* (Haworth)		05-16-01	UV
[c] *Hypomecis gnopharia* (Guenée)		08-15-01	UV
[c] *Lambdina athasaria* (Walker) complex		08-14-01	UV
[c] *Melanolophia canadaria* (Guenée)		09-19-01	UV
[c] *Metarranthis hypocharia* (Herrich-Schäffer)		06-19-01	UV
[c] *Patalene olyzonaria puber* (Grote & Robinson)		06-19-01	UV
[c] *Plagodis alcoolaria* (Guenée)		08-15-01	UV
[c] *Prochoerodes transversata* (Drury)		09-21-01	UV
[c] *Scopula inductata* (Guenée)		05-16-01	UV
[c] *Scopula limboundata* (Haworth)		05-31-01	UV
[c] *Semiothisa aemulataria* (Walker)		05-16-01	UV
[c] *Semiothisa gnophosaria* (Guenée)		09-20-01	UV
HESPERIIDAE			
Ancyloxypha numitor (Fabricius)	Least skipperling	09-06-01	SW
[c] *Atalopedes campestris* (Boisduval)*	Sachem	09-06-01	SW
[c] *Euphyes vestris* (Boisduval)*	Dun skipper	06-19-01	SW
[c] *Lerema accius* (Smith)*	Clouded skipper	09-06-01	SW
[c] *Nastra lherminier* (Latreille)	Swarthy skipper	06-19-01	SW
Poanes viator zizaniae Shapiro*	Broad wing skipper	09-06-01	SW
[c] *Poanes zabulon* (Boisduval & Leconte)*	Zabulon skipper	06-19-01	SW
[c] *Polites origenes* (Fabricius)*	Crossline skipper	09-06-01	SW
[c] *Polites themistocles* (Latreille)*	Tawny-edged skipper	08-16-01	SW
[c] *Pompeius verna* (Edwards)	Little glassywing	09-18-01	SW
Pyrgus communis (Grote)*	Common checkered skipper	10-23-01	SW
[c] *Thorybes bathyllus* (Smith)*	Southern cloudywing	08-01-01	SW
LYCAENIDAE			
Calycopis cecrops (Fabricius)	Red-banded hairstreak	05-15-01	SW
[c] *Everes comyntas* (Godart)	Eastern tailed blue	06-29-01	SW
NOCTUIDAE			
[c] *Abagrotis alternata* (Grote)		09-21-01	UV
[c] *Acronicta inclara* Smith complex		05-16-01	UV
[c] *Agrotis ipsilon* (Hufnagel)		05-16-01	UV
[c] *Allotria elonympha* (Hübner)		08-14-01	UV
[c] *Amphipyra pyramidoides* Guenée		08-15-01	UV
[c] *Anicla infecta* (Ochs.)		09-20-01	UV
[c] *Anorthodes tarda* (Guenée)		05-16-01	UV
[c] *Arugisa latiorella* (Walker)		09-07-01	UV
[c] *Bleptina caradrinalis* Guenée		05-16-01	UV
[c] *Caenurgia chloropha* (Hübner)		08-15-01	UV
[c] *Chytolita morbidalis* (Guenee)		05-16-01	UV
[c] *Chytonix palliatricula* (Guenée)		05-16-01	UV
[c] *Cirrhophanus triangulifer* Grote		09-07-01	UV
[c] *Condica videns* (Guenée)		09-18-01	UV
[c] *Elaphria festivoides* (Guenée)		05-16-01	UV
[c] *Elaphria grata* Hübner		08-14-01	UV
[c] *Feltia herilis* (Grote)		09-18-01	UV
[c] *Galgula partita* Guenée		08-15-01	UV

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
LEPIDOPTERA (continued)			
NOCTUIDAE (continued)			
[c] *Hypena baltimoralis* Guenée		08-15-01	UV
[c] *Hypena manalis* Walker		06-19-01	UV
[c] *Hypena scabra* (Fabricius)		05-31-01	UV
[c] *Idia aemula* Hübner		08-15-01	UV
[c] *Idia americalis* (Guenée)		08-15-01	UV
[c] *Idia scobialis* (Grote)		08-15-01	UV
[c] *Lacinipolia laudabilis* (Guenée)		09-18-01	UV
[c] *Lacinipolia renigera* (Stephens)		05-16-01	UV
[c] *Lithacodia muscosula* (Guenée)		08-15-01	UV
[c] *Meganola phylla* (Dyar)		05-16-01	UV
[c] *Meropleon diversicolor diversicolor* (Morrison)		09-20-01	UV
[c] *Nedra ramosula* (Guenée)		09-19-01	UV
[c] *Ogdoconta cinereola* (Guenée)		09-20-01	UV
[c] *Orthodes crenulata* (Butler)		05-16-01	UV
[c] *Paectes abrostoloides* (Guenée)		08-13-01	UV
[c] *Palthis angulalis* (Hübner)		08-15-01	UV
[c] *Palthis asopialis* (Guenée)		08-15-01	UV
[c] *Pangrapta decoralis* Hübner		06-19-01	UV
[c] *Phalaenostola larentioides* Grote		09-07-01	UV
[c] *Phosphila miselioides* (Guenée)		06-19-01	UV
[c] *Plathypena scabra* (Fabricius)		08-15-01	UV
[c] *Polygrammate hebraeicum* Hübner		05-16-01	UV
[c] *Pseudaletia unipuncta* (Haworth)		08-15-01	UV
[c] *Redectis vitrea* (Grote)		08-15-01	UV
[c] *Renia sobrialis* (Walker)		09-19-01	UV
[c] *Renia* sp. near *discoloralis* Guenée		08-15-01	UV
[c] *Spodoptera ornithogalli* (Guenée)		08-14-01	UV
[c] *Sutyna privata teltowa* (Smith)		09-19-01	UV
[c] *Tetanolita mynesalis* (Walker)		08-15-01	UV
[c] *Thioptera nigrofimbria* (Guenée)		08-15-01	UV
[c] *Ulolonche culea* (Guenée)		05-16-01	UV
[c] *Xestia dolosa* Franclemont		08-15-01	UV
[c] *Zale horrida* Hübner		05-16-01	UV
[c] *Zale lunata* (Drury)		08-15-01	UV
NOTODONTIDAE			
[c] *Clostera inclusa* (Hübner)		08-15-01	UV
[c] *Heterocampa obliqua* Packard		06-19-01	UV
[c] *Heterocampa umbrata* Walker		06-19-01	UV
[c] *Hyperaeschra georgica* (Herrich-Schäffer)		05-16-01	UV
[c] *Lochmaeus manteo* Doubleday		08-15-01	UV
[c] *Nadata gibbosa* (J. E. Smith)		05-16-01	UV
[c] *Oligocentria lignicolor* (Walker)		09-07-01	UV
[c] *Peridea angulosa* (J. E. Smith)		09-20-01	UV
[c] *Symmerista albifrons* (J. E. Smith) complex		08-14-01	UV
NYMPHALIDAE			
[c] *Cercyonis pegala* (Fabricius)*	Large wood nymph	06-29-01	SW
Cyllopsis gemma (Hübner)	Gemmed satyr	09-06-01	SW
Danaus plexippus (Linnaeus)	Monarch	09-18-01	HV
[c] *Enodia anthedon* (Clark)	Northern pearly eye	09-21-01	SW
[c] *Hermeuptychia sosybius* (Fabricius)	Carolina satyr	07-11-01	SW
[c] *Junonia coenia* Hübner*	Buckeye	07-11-01	SW
Limenitis arthemis astyanax (Fabricius)	Red spotted purple	07-11-01	HV
[c] *Megisto cymela* (Cramer)*	Little wood satyr	05-31-01	SW
Nymphalis antiopa (Linnaeus)	Mourning cloak	05-31-01	HV
[c] *Phyciodes tharos* (Drury)*	Southern pearly crescentspot	07-11-01	SW
Polygonia comma (Harris)	Comma	05-31-01	HV
[c] *Satyrodes appalachia* (Chermock)	Appalachian brown	06-29-01	SW
Vanessa atalanta (Linnaeus)*	Red admiral	05-31-01	HV
Vanessa cardui (Linnaeus)	Painted lady	09-06-01	HV
Vanessa virginiensis (Drury)*	American painted lady	05-31-01	HV

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	DATE FIRST OBSERVED	METHOD
LEPIDOPTERA (continued)			
PAPILIONIDAE			
Papilio glaucus Rothschild & Jordan	Tiger swallowtail	06-19-01	HV
Papilio troilus (Linnaeus)	Spicebush swallowtail	08-13-01	HV
PIERIDAE			
Anthocharis midea (Hübner)	Falcate orangetip	04-19-01	SW
Colias eurytheme Boisduval	Orange sulphur	08-14-01	SW
Phoebis sennae (Linnaeus)	Cloudless giant sulphur	09-06-01	HV
SATURNIIDAE			
[c] *Dryocampa rubicunda* (Fabricius)		08-15-01	UV
SPHINGIDAE			
[c] *Dolba hyloeus* (Drury)		08-13-01	UV
[c] *Lapara bombycoides* Walker		08-15-01	UV
[c] *Paonias excaecatus* (J. E. Smith)		08-15-01	UV
ODONATA (DRAGONFLIES and DAMSELFLIES)			
AESHNIDAE			
Anax junius (Drury)	Common green darner	06-18-01	HV
[c] *Epiaeschna heros* (Fabricius)*	Swamp darner	07-11-01	SW
COENAGRIONIDAE			
Ischnura posita (Hagen)	Fragile forktail	06-29-01	SW
CORDULIIDAE			
[c] *Epitheca cynosura* (Say)*	Common baskettail	04-19-01	SW
[c] *Somatochlora linearis* (Hagen)*	Mocha emerald	08-16-01	SW
LIBELLULIDAE			
[c] *Celithemis elisa* (Hagen)*	Calico pennant	05-31-01	SW
[c] *Erythemis simplicicollis* (Say)	Eastern pondhawk	06-29-01	SW
[c] *Libellula cyanea* Fabricius	White-spangled skimmer	06-29-01	SW
[c] *Libellula flavida* Rambur*	Yellow-sided skimmer	06-29-01	SW
[c] *Libellula incesta* Hagen	Slaty skimmer	07-11-01	SW
Libellula lydia Drury	Common whitetail	06-18-01	SW
Libellula needhami Westfall*	Needham's skimmer	09-06-01	SW
[c] *Libellula semifasciata* Burmeister	Painted skimmer	06-29-01	SW
[c] *Libellula vibrans* Fabricius	Great blue skimmer	06-29-01	SW
[c] *Pachydiplax longipennis* (Burmeister)	Blue dasher	06-29-01	SW
Pantala flavescens (Fabricius)	Wandering glider	09-18-01	SW
[c] *Pantala hymenaea* (Say)	Spot-winged glider	08-13-01	SW
[c] *Sympetrum vicinum* (Hagen)*	Yellow-legged meadowfly	10-04-01	SW

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Banisteria, Number 22, 2003

Butterflies and Skippers Recorded from the Southern Tip of the Delmarva Peninsula, 1995-2003

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INTRODUCTION

Little recent information is available about the butterflies and skippers that inhabit the southern tip of the Delmarva Peninsula in Northampton County, Virginia. The butterfly fauna of the Delmarva Peninsula was treated by Woodbury (1994), but his book lacks range maps or information specific to the Virginia portion of the peninsula. Statewide references on butterflies and skippers of Virginia (Clark & Clark, 1951; Pavulaan, 1995) contain county-level records that include Northampton County. Clark & Clark (1951) also listed specific localities in Northampton County for a few species.

An interesting and rare phenomenon, a fallout, or mass grounding of butterflies (at least nine species involved) and dragonflies, was observed on 27 May 2000 at the Chesapeake Bay Bridge-tunnel, about 10-20 km southwest of the tip of the Delmarva Peninsula (Taber, 2002).

In 1995, volunteers and staff of Coastal Virginia Wildlife Observatory (CVWO), a non-profit organization formed in 1994, initiated regular surveys of butterflies and skippers throughout the year at the southern tip of the Delmarva Peninsula to document the current status of the fauna. A checklist of the butterflies and skippers found in the area has been produced by CVWO, distributed to the public, and updated as of June 2003.

METHODS AND STUDY AREAS

CVWO has employed professional biologists annually since 1995 to study bird migration. Several of those staff, in the course of their bird research duties and in their spare time, have paid close attention to butterflies and skippers, particularly in the three main study areas: Kiptopeke State Park (KSP), the Eastern Shore of Virginia National Wildlife Refuge (ESVNWR), and the GATR Tract, a Virginia Department of Game and Inland Fisheries Wildlife Management Area (GATR). These sites are located in the southern 6 km of the Delmarva Peninsula (Fig.1).

Volunteers, including the author, have spent considerably more time than staff recording observations at all seasons. To facilitate the studies and also for enjoyment by visitors, a butterfly garden was established in 1996 at KSP by CVWO volunteers. CVWO also helps manage a butterfly garden established by ESVNWR in 1999. The gardens provide nectaring opportunities for adult butterflies and skippers and food plants for caterpillars. The most predominant

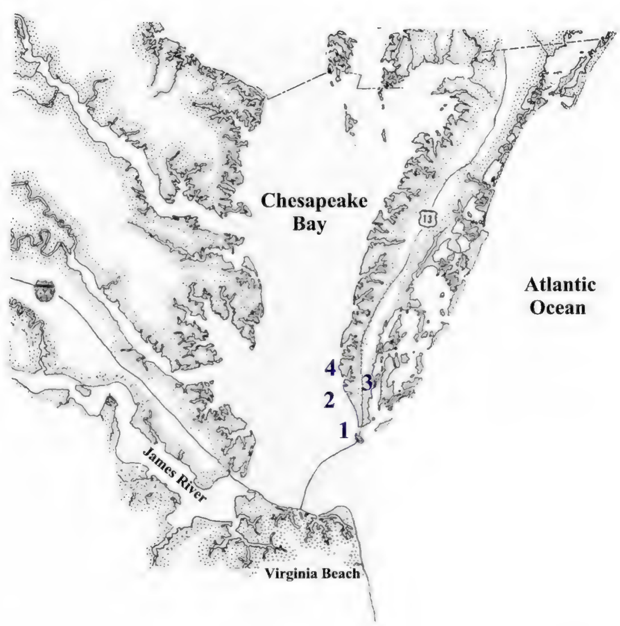

Fig 1. Map showing main study areas at the southern end of the Delmarva Peninsula, Northampton County, Virginia (1 = Fisherman Island National Wildlife Refuge, 2 = ESVNWR, 3 = GATR, 4 = KSP).

plants in the gardens are: Butterfly Bush (*Buddleia davidii*), Round Head Bush Clover (*Lespedeza capitata*), Blue Salvia (*Salvia guaranictia*), Joe-Pye Weed (*Eupatorum purpureum*), Butterfly Weed (*Asclepias tuberosa*), Seaside Goldenrod (*Solidago sempervirens*), Tansy (*Tanacetum vulgare*), Catnip (*Nepeta cataria*), Bergamot (*Monarda didyma*), Lamb's Ears (*Stachys byzantina*), Rose Root (*Sedum rosea*), Homestead Verbena (*Verbena canadensis*), and Lantana (*Lantana camara*). The gardens draw a wide variety of butterflies and skippers from March to early December.

In addition to the butterfly gardens, observations have been made primarily along the trails at KSP, ESVNWR, and GATR. Both KSP and ESVNWR have stands of *Abelia* bushes, approximately 20 m long and 50 m long, respectively, which have proven to be extremely attractive to butterflies and skippers and have concentrated them for easy, close-range study. Predominant habitats at the tip of the Delmarva Peninsula include small, mixed forest patches, containing Loblolly Pine (*Pinus taeda*) and Virginia Pine (*Pinus virginiana*), oaks (*Quercus* spp.), hollies (*Ilex* spp.), maples (*Acer* spp.), and other hardwoods; fallow fields; Wax Myrtle (*Myrica cerifera*) stands; thick understories of Poison Ivy (*Toxicodendron radicans*) and honeysuckle (*Lonicera*); freshwater ponds; saltmarsh; dunes and beaches. In addition, there are agricultural fields which mainly produce soybeans, wheat, string beans, cucumbers, squash, tomatoes, cotton, and sweet potatoes.

In 1999, CVWO began conducting the annual 4th of July Butterfly Count, organized by the North American Butterfly Association, within a designated 24 km diameter survey area. The count, named "Delmarva Tip" and centered around Capeville, uses the same circle as the annual National Audubon Society Christmas Bird Count.

RESULTS AND DISCUSSION

A total of 66 species of butterflies and skippers was documented in the study area (Table 1). No specimens were collected, but many species were photographed and are so noted in the table. Multiple observers have documented the presence of 63 of the 66 species, from 1995-2003. The following four species are represented by a single observation:

Southern Dogface (*Colias cesonia*) - found by Bob Ake near KSP on 9 November 2002. Clark & Clark (1951) listed a record of this species from Bayford, Northampton County, which is plotted by Pavulaan (1995), but lacking from USGS (2002).

Hayhurst's Scallopwing (*Staphylus hayhurstii*) – observed by Hal Wierenga and Lynn Davidson at Oyster on 26 July 2003 during the 5th annual 4th of July Butterfly Count. This is the first record of this species from Northampton County.

Southern Broken-Dash (*Wallengrenia otho*) - observed by Mark Garland at ESVNWR on 14 September 1998. This species was previously recorded from Northampton County by Burns (1985).

Brazilian Skipper (*Calpodes ethlius*) - found by the author, Calvin Brennan, and Chad Runco and photographed by Fletcher Smith (Fig. 2) at ESVNWR on 1 December 2001. The temperature was 22 °C. This is apparently a new record for Northampton County, but the species was previously recorded from neighboring Accomack County by Clark & Clark (1951).

The following four additional species found during this study are apparently new records for Northampton County (Pavulaan, 1995; USGS, 2002): Sleepy Orange (*Eurema nicippe*), Crossline Skipper (*Polites origenes*), Little Glassywing (*Pompeius verna*), and Common Roadside Skipper (*Amblyscirtes vialis*). Aaron's Skipper (*Poanes aaroni*), another species that was observed during this study, was recorded from Northampton County by Clark & Clark (1951), but is not plotted by Pavulaan (1995) or USGS (2002). Sleepy Orange (Fig. 3) has been found by Calvin Brennan and the author at ESVNWR and KSP, including dates of 1 May 2000, 1 April 2001, and 14 April 2001. Crossline Skipper has been found at the Kiptopeke Butterfly Garden by Lynn Davidson, Hal Wierenga, Calvin Brennan, the author, and others, often feeding on *Lespedeza capitata* in late August and through September. Little Glassywing was found by Calvin Brennan and the author on 19 August 2000 at the Kiptopeke Butterfly Garden and four were observed on 20 July 2002 during the 4th of July Butterfly Count. Common Roadside Skipper was found separately by the author and Larry Brindza, on 4th of July Butterfly Counts on 18 July 1999 and 20 July 2002, respectively.

Five additional species represented by fewer than five observations are Pipevine Swallowtail (*Battus philenor*), Giant Swallowtail (*Papilio cresphontes*), White M Hairstreak (*Parrhasius m-album*), Gulf Fritillary (*Agraulis vanillae*), and Northern Broken-Dash (*Wallengrenia egeremet*). Both swallowtails have been observed at ESVNWR by multiple observers, and at least the Giant Swallowtail also at KSP by the author. Single adult White M Hairstreaks were observed at KSP by the author and Brennan in April 2001 and by

Table 1. Butterflies and skippers found near the southern tip of the Delmarva Peninsula, Northampton County, Virginia, 1995-2003. Scientific and common names follow Glassberg (1999), except for American Holly Azure (see Wright & Pavulaan, 1999) and Summer Azure (see USGS, 2002).

Common Name	**Scientific Name**	**Documentation[1]**	**Relative Abundance[2]**	**Distribution Records[3]**
Pipevine Swallowtail	*Battus philenor*	Sight	Rare	
Black Swallowtail	*Papilio polyxenes*	Photograph	Common	
Giant Swallowtail	*Papilio cresphontes*	Sight	Rare	C&C
Eastern Tiger Swallowtail	*Papilio glaucus*	Photograph	Common	
Spicebush Swallowtail	*Papilio troilus*	Photograph	Common	C&C
Palamedes Swallowtail	*Papilio palamedes*	Photograph	Common	C&C
Cabbage White	*Pieris rapae*	Photograph	Common	
Falcate Orangetip	*Anthocharis midea*	Photograph	Common	
Clouded Sulphur	*Colias philodice*	Photograph	Common	
Orange Sulphur	*Colias eurytheme*	Photograph	Common	C&C
Southern Dogface	*Colias cesonia*	Sight	Rare	C&C
Cloudless Sulphur	*Phoebis sennae*	Photograph	Common	
Little Yellow	*Eurema lisa*	Sight	Uncommon	
Sleepy Orange	*Eurema nicippe*	Photograph	Uncommon	N
Henry's Elfin	*Incisalia henrici*	Photograph	Common	
Eastern Pine Elfin	*Incisalia niphon*	Sight	Common	
White M Hairstreak	*Parrhasius m-album*	Sight	Rare	
Gray Hairstreak	*Strymon melinus*	Photograph	Common	
Red-banded Hairstreak	*Calycopis cecrops*	Photograph	Common	
Eastern Tailed Blue	*Everes comyntas*	Photograph	Common	
American Holly Azure	*Celastrina idella*	Photograph	Common	
Summer Azure	*Celastrina neglecta*	Photograph	Common	
American Snout	*Libytheana carinenta*	Photograph	Common	C&C
Gulf Fritillary	*Agraulis vanillae*	Photograph	Rare	
Variegated Fritillary	*Euptoieta claudia*	Photograph	Common	
Pearl Crescent	*Phyciodes tharos*	Photograph	Common	
Question Mark	*Polygonia interrogationis*	Photograph	Common	
Eastern Comma	*Polygonia comma*	Photograph	Uncommon	C&C
Mourning Cloak	*Nymphalis antiopa*	Sight	Common	C&C
American Lady	*Vanessa virginiensis*	Photograph	Common	
Painted Lady	*Vanessa cardui*	Photograph	Common	
Red Admiral	*Vanessa atalanta*	Photograph	Common	
Common Buckeye	*Junonia coenia*	Photograph	Common	
Red-spotted Purple	*Limenitis arthemis astyanax*	Photograph	Common	
Viceroy	*Limenitis archippus*	Photograph	Uncommon	
Hackberry Emperor	*Asterocampa celtis*	Sight	Uncommon	
Tawny Emperor	*Asterocampa clyton*	Sight	Uncommon	C&C
Little Wood-Satyr	*Megisto cymela*	Sight	Uncommon	
Common Wood-Nymph	*Cercyonis pegala*	Photograph	Common	
Monarch	*Danaus plexippus*	Sight	Common	
Silver-spotted Skipper	*Epargyreus clarus*	Photograph	Common	
Long-tailed Skipper	*Urbanus proteus*	Sight	Uncommon	
Hayhurst's Scallopwing	*Staphylus hayhurstii*	Sight	Rare	N
Juvenal's Duskywing	*Erynnis juvenalis*	Photograph	Common	
Horace's Duskywing	*Erynnis horatius*	Photograph	Common	
Wild Indigo Duskywing	*Erynnis baptisiae*	Sight	Common	

Table 1 (continued).

Common Name	Scientific Name	Documentation[1]	Relative Abundance[2]	Distribution Records[3]
Common Checkered-Skipper	*Pyrgus communis*	Photograph	Common	
Common Sootywing	*Pholisora catullus*	Photograph	Common	
Swarthy Skipper	*Nastra lherminier*	Photograph	Common	
Clouded Skipper	*Lerema accius*	Photograph	Common	C&C
Least Skipper	*Ancyloxypha numitor*	Photograph	Uncommon	
Fiery Skipper	*Hylephila phyleus*	Photograph	Common	
Tawny-edged Skipper	*Polites themistocles*	Sight	Uncommon	
Crossline Skipper	*Polites origenes*	Sight	Uncommon	N
Southern Broken-Dash	*Wallengrenia otho*	Sight	Rare	
Northern Broken-Dash	*Wallengrenia egeremet*	Sight	Rare	
Little Glassywing	*Pompeius verna*	Photograph	Rare	N
Sachem	*Atalopedes campestris*	Photograph	Common	
Zabulon Skipper	*Poanes zabulon*	Photograph	Common	
Aaron's Skipper	*Poanes aaroni*	Sight	Rare	C&C
Broad-winged Skipper	*Poanes viator*	Photograph	Uncommon	
Dun Skipper	*Euphyes vestris*	Photograph	Uncommon	
Common Roadside-Skipper	*Amblyscirtes vialis*	Sight	Rare	N, D
Brazilian Skipper	*Calpodes ethlius*	Photograph	Rare	N
Saltmarsh Skipper	*Panoquina panoquin*	Sight	Common	C&C
Ocola Skipper	*Panoquina ocola*	Sight	Uncommon	

[1] All photographs by Calvin Brennan except Gulf Fritillary (Larry Brindza, Ned Brinkley) and Brazilian Skipper (Fletcher Smith).

[2] Common (generally found during proper season in proper habitat); Uncommon (found only sporadically or in small numbers at proper season in proper habitat); Rare (<5 records).

[3] N = Northampton County record; D = Delmarva Peninsula record; C&C = species reported from Northampton County by Clark & Clark (1951); common statewide species were often reported as such, without county by county lists.

Fig. 2. Brazilian Skipper (*Calpodes ethlius*) photographed by Fletcher Smith at Eastern Shore of Virginia National Wildlife Refuge on 1 December 2001.

Fig. 3. Sleepy Orange (*Eurema nicippe*) photographed by Calvin Brennan at Eastern Shore of Virginia National Wildlife Refuge on 1 April 2001.

CVWO staff Chad Runco in August 2001. Northern Broken-Dash was observed several times by Mark Garland, including at KSP. Single Gulf Fritillaries were recorded on five dates, including four during the same week, as follows: (1) observed near KSP by Andy Davis on 20 September 2000; (2) seen and photographed on lantana at ESVNWR butterfly garden on 2-3 October 2002 by multiple observers; (3) photographed near Cape Charles on 3 October 2002 by Ned Brinkley; and (4) observed on the Chesapeake Bay Bridge-tunnel on 6 October 2002 by Bill Akers, Peggy Speigel, and Bill Opengari.

Species that were not found in the study area but which occur regularly just across the mouth of Chesapeake Bay (cities of Norfolk and Virginia Beach) include Zebra Swallowtail (*Eurytides marcellus*), Gemmed Satyr (*Cyllopsis gemma*), and Carolina Satyr (*Hermeuptychia sosybius*). Clark & Clark (1951) also noted the absence of Zebra Swallowtails on the Eastern Shore. Fifteen species previously recorded from Northampton County, but which were not found during this study period, are listed in Table 2. Two of these, Diana Fritillary (*Speyeria diana*) and Silver-bordered Fritillary (*Boloria selene*), were last recorded in the county prior to 1930 (Clark & Clark, 1951) and are likely extirpated. Diana Fritillary may be extirpated from the Coastal Plain of Virginia (West & Opler, 1979).

The results of the five 4th of July Butterfly Counts conducted to date appear in Table 3. Fisherman Island was only surveyed in 1999. The cumulative total is 45 species. While the results are interesting, meaningful comparisons cannot be made, because the number of observers, distances traveled, and field hours have not been standardized for this count. An astounding 24,901 Cabbage Whites (*Pieris rapae*), a non-native butterfly species, were estimated in agricultural fields during the 2002 count, mainly associated with Black Mustard (*Brassica nigra*). This figure was exceeded the following year by an estimated count of 33,018 Cabbage Whites.

In 1998, a Monarch (*Danaus plexippus*) migration program was begun by CVWO Board member Mark Garland, which includes late summer and fall censuses, roost site monitoring, and tagging. More than 2,600 Monarchs have been tagged from 1998 through 2002 (Davis & Garland, 2002; Davis & Garland, in press; Garland & Davis, 2002). Two of these Monarchs were recovered at the winter roost site in El Rosario, Mexico on 26 January 2001 and 16 February 2002.

In addition to Monarchs, one other species, Red Admiral (*Vanessa atalanta*), has been observed in active, straight-line seasonal migration, especially past the hawkwatch observation platform at KSP, during August and September (pers. obs). However, no census of the movement of Red Admirals has been undertaken.

Table 2. Butterflies and skippers recorded previously from Northampton County (Clark & Clark, 1951; Pavulaan, 1995; USGS, 2002) but not found by CVWO volunteers and staff during this study.

Great Purple Hairstreak (*Atlides halesus*)
Coral Hairstreak (*Harkenclenus titus*)
Olive Hairstreak (*Mitoura grynea*)
Brown Elfin (*Incisalia augustinus*)
Diana Fritillary (*Speyeria diana*)
Great Spangled Fritillary (*Speyeria cybele*)
Silver-bordered Fritillary (*Boloria selene*)
Southern Pearly Eye (*Enodia portlandia*)
Hoary Edge (*Achalarus lyciades*)
Southern Cloudywing (*Thorybes bathyllus*)
Northern Cloudywing (*Thorybes pylades*)
Sleepy Duskywing (*Erynnis brizo*)
Zarucco Duskywing (*Erynnis zarucco*)
Peck's Skipper (*Polites peckius*)
Delaware Skipper (*Anatrytone logan*)

This study represents a comprehensive attempt to (1) better understand the butterfly and skipper populations at the southern tip of the Delmarva Peninsula, and (2) make recommendations about possible management strategies. CVWO plans to continue the studies. More species will certainly be found as the coverage increases. Professionals and volunteers conducting similar studies in the area are encouraged to share their results with CVWO.

ACKNOWLEDGMENTS

Principal field researchers besides the author were Mark Garland, Calvin Brennan, Hal Wierenga, Lynn Davidson, Andy Davis, Marshall Iliff, Bob Ake, Larry Brindza, and Brian Sullivan. Additional 4th of July Butterfly Count participants were Rebecca Agule, Matt Akel, Bob Anderson, Danny Bell, Ned Brinkley, Camille Darby, Nicole Eaton, Sheila Faith, Dot Field, Teta Kain, and Bill Williams. 4th of July Count compilers are Davidson and Wierenga. Mark Garland, Calvin Brennan, Lynn Davidson and Hal Wierenga reviewed this paper and made helpful suggestions. Steve Roble made many suggestions about the content, organization, and literature citations of the paper. Access to research areas and tagging permits were made possible through the cooperation of Dave Summers and the KSP staff and Susan Rice and the ESVNWR staff.

Table 3. Results of 4th of July Butterfly Counts conducted at the southern tip of the Delmarva Peninsula, 1999-2003.

Common Name	18 July 1999	30 July 2000	28 July 2001	20 July 2002	26 July 2003
Pipevine Swallowtail	0	0	0	1	0
Black Swallowtail	4	30	0	89	160
Eastern Tiger Swallowtail	7	6	3	50	85
Spicebush Swallowtail	5	55	17	79	155
Palamedes Swallowtail	2	13	6	8	20
Dark swallowtail sp.	0	0	0	15	6
Cabbage White	1,310	2,209	52	24,901	33,018
Clouded Sulphur	2	1	2	33	18
Orange Sulphur	4	13	2	254	130
Cloudless Sulphur	0	0	0	13	1
Gray Hairstreak	0	5	0	15	3
Red-banded Hairstreak	2	45	0	1	1
Eastern Tailed Blue	0	24	0	10	5
Summer Azure	0	2	0	4	1
American Snout	0	12	0	5	111
Variegated Fritillary	0	42	0	60	3
Pearl Crescent	2	14	1	27	15
Question Mark	0	1	2	1	10
American Lady	2	7	22	9	90
Painted Lady	0	0	1	0	8
Red Admiral	2	5	4	1	9
Common Buckeye	6	65	0	354	197
Red-spotted Purple	0	8	1	2	1
Viceroy	0	0	0	3	2
Hackberry Emperor	0	1	1	7	38
Tawny Emperor	0	0	0	0	7
Common Wood-Nymph	12	38	0	9	41
Monarch	10	0	6	3	6
Silver-spotted Skipper	56	63	38	685	393
Hayhurst's Scallopwing	0	0	0	0	1
Horace's Duskywing	3	1	1	7	7
Common Checkered Skipper	0	0	0	27	2
Common Sootywing	0	11	0	52	16
Swarthy Skipper	0	8	0	3	0
Clouded Skipper	1	0	0	2	0
Least Skipper	0	4	1	1	7
Fiery Skipper	9	0	0	21	2
Northern Broken-Dash	0	1	0	0	0
Little Glassywing	0	0	0	4	0
Sachem	1	1	0	48	4
Zabulon Skipper	0	2	0	1	0
Broad-winged Skipper	0	2	0	20	6
Dun Skipper	1	3	0	2	0
Common Roadside-Skipper	1	0	0	1	0
Saltmarsh Skipper	0	0	0	0	7
Ocola Skipper	0	0	0	0	1
Total Species	21	31	17	39	37
Total individuals	1,442	2,692	160	26,828	34,597
Cumulative species total	21	35	36	41	45
Number of observers	4	8	1	8	6
Number of party hours	6	14	4	23.5	26.5

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Banisteria, Number 22, 2003

Beetles of the Genus *Anthophylax* in Virginia (Coleoptera: Cerambycidae: Lepturinae)

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In a family of beetles renowned for their spectacular form and coloration, species of the Nearctic genus *Anthophylax* are, by virtue of their vivid green to rosaceus metallic hues, no less impressive than their larger tropical relatives. Three species occur in northeastern North America, and extend southward along the Appalachians into western Virginia; a fourth is endemic to high elevations in the Southern Blue Ridge and is here newly recorded from Virginia at its northernmost known locality. Virginia becomes the first state in which all four members of the genus are known to occur.

The species of *Anthophylax* do not share the predilection of lepturines generally to congregate at flowers of such low-growing plants as *Hydrangea, Ceanothus,* and *Cimicifuga*, and as a result are not commonly represented in collections (for example, the VPISU collection, replete with scores of cerambycids in other genera of Lepturini, has no Virginia specimens of any of the four endemic species). On the contrary, virtually all of the numerous VMNH specimens were taken in pitfall traps (a few were attracted to UV light), implying a distinctive life style within the tribe. Adults of some species are thought to feed on the pollen of male gymnosperm cones, and several are known to visit the flower clusters of mountain maple (*Acer spicatum*).

It is hoped that this brief synopsis of the genus as it occurs in Virginia will stimulate local interest in our fauna, leading to a better knowledge of the geographic and seasonal distribution of our species, and their biology. All of the VMNH specimens of all four species were collected during the first half of June, implying a rather short period of adult activity and restricting the time in which these beetles can be collected or observed.

Genus **Anthophylax** LeConte

A genus of Lepturini characterized by distinct lateral pronotal projections and deep subapical constriction, coarsely faceted eyes, terminally placed tibial spurs, and eyes deeply emarginate around antennal sockets.

The latest treatment of the genus is the excellent summary by Linsley & Chemsak (1972) which gives detailed descriptions of each species and a complete listing of relevant literature. All except *A. hoffmani* are illustrated in color by Yanega (1996). *Anthophylax quadrimaculatus* Champlain & Knull is currently placed in *Centrodera.*

Key to the species of *Anthophylax*

1. Integument not metallic; elytra brown, not obviously punctate, invested with short recumbent silvery setae..*attenuatus*
- Integument bright shiny metallic; elytra green or purplish gold, with rows of large round punctations, only a few small scattered setae 2
2. Pronotum dorsally flattened, the surface very coarsely punctate-rugulose, with a shallow subcircular depression each side near base of the large lateral projections, and a distinct polished subbasal transverse ridge................................*hoffmani*
- Pronotum evenly convex, smooth, punctations small and separated, no trace of rugosity or other surface texture, no paramedian depressions nor subbasal polished ridge..3
3. Elytra apically rounded; pronotum similar in color and texture to the elytra; legs orange..............*cyaneus*
- Elytra apically acute; pronotum piceous to black and much less metallic than the elytra; legs black...*viridis*

Anthophylax attenuatus (Haldeman)
New southernmost localities

The distribution map in Linsley & Chemsak (1972: 74) shows localities extending from Minnesota to Nova Scotia, and southward as far as Page County, Virginia. Recent collections extend the range still further along the Appalachians:

Augusta Co. Shenandoah Mountain, pitfall site off FS 85, 3 mi. S jct. FS 95, 17 June 1988, K. A. Buhlmann (2). *Wise Co.*: FS cabin off Rt. 706, 5 km (airline) SSW Tacoma, 6-9 June 1993, S. M. Roble (1).

At the Shenandoah Mountain locality, the two *A. attenuatus* were captured in the same pitfalls, in the same time interval, with one specimen of *A. viridis* and many individuals of *A. cyaneus*. This may be the first recorded instance of triple syntopic synchrony for these beetles.

Occurrence of the species in Wise County (High Knob region) virtually assures that it will be found in eastern Kentucky and perhaps in Tennessee and North Carolina as well.

Anthophylax hoffmani Beutenmüller
New state and northernmost locality

Originally described from "Black Mountain, N. C." (Beutenmüller, 1903), this species has been subsequently recorded from as far south and west as the Great Smoky Mountains. The record for Cornelia, Georgia by Fattig (1947) seems improbable, as neither fir nor red spruce occur in that state, and the specimens upon which the record was based are no longer extant (Turnbow & Franklin, 1980). Since the type specimens were found associated with Fraser fir (*Abies fraseri*), the type locality can be restricted to the highest parts of the Black Mountains, probably above 5000 ft. on Mount Mitchell itself. The type series, two males and four females, was taken during the period June 26 to July 11, 1902.

As the species has not been recorded north of the Black Mountains, the capture of a specimen in southwestern Virginia represents a range extension of some 85 miles/140 km and doubles the geographic area in which the species is known to occur.

Russell Co.: west side of Beartown Mountain, a prominence of Clinch Mountain east of Rosedale, 3800-4000 feet ASL, 7 June 1988, C. A. Pague and D. A. Young (1).

This new locality is of interest for an additional reason. Existing information on the host plant of *A. hoffmani* associates it with Fraser fir, which, like the beetle, is endemic to the Southern Blue Ridge. This conifer occurs at Mount Rogers, Virginia, where the beetle is thus to be expected, but not at the Clinch Mountain site where red spruce (*Picea rubens*) is present. The fact that *A. hoffmani* can utilize this tree as a food source opens the possibility that it may be found still farther northeast at several sites along Clinch Mountain (such as Burkes Garden) where small stands of red spruce are recovering from near-extirpation by logging activities almost a century ago.

Although superficially similar to both *A. viridis* and *A. cyaneus*, it is nonetheless endowed with enough specialized features (e.g., strong development of surface sculpture as noted in the key) that on direct comparison of the three, I cannot assert that *A. hoffmani* is more closely related (similar) to one than to the other. Presumably, there was a common ancestor that existed in the Southern Appalachians at some time prior to the local evolution of *A. hoffmani* as an obligate associate of Fraser fir (and secondarily, red spruce).

This striking beetle (Fig. 1) was named for Beutenmüller's friend "...the late Very Rev. E. A. Hoffman..." a New York clergyman not related to the present author.

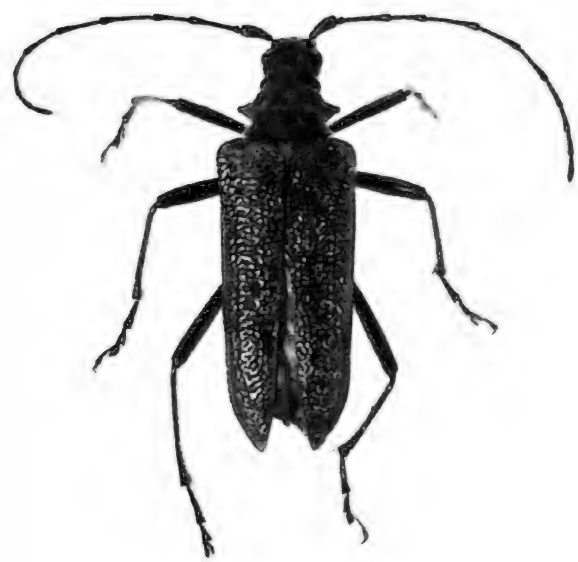

Fig. 1. *Anthophylax hoffmani* from Beartown Mountain, Russell County, Virginia; body length = 18 mm (from labrum to elytral apex) (photograph by Melody Cartwright, VMNH).

Anthophylax cyaneus (Haldeman)

Widely distributed across northeastern North America from Nova Scotia to Michigan, and south in the Appalachians to northern Georgia, this species should be more generally distributed in the mountainous parts of the state than our few records - all of which are concentrated in a fairly small area in central western Alleghanies - might suggest. As both this species and the following are known to aggregate at the inflorescence of mountain maple (*Acer spicatum*), the attention of collectors is directed to this likely source for additional captures.

Augusta Co.: 5 mi W of Stokesville, 1 October 1988 (2); 16-17 June 1989 (4), all B. Flamm. Shenandoah Mountain, 5 mi SW Reddish Knob, 17 June 1988 (1); 3 mi S of FS 95, 17 June 1988 (15), all K. A. Buhlmann. *Highland Co.*: Locust Springs, Laurel Fork Recreation Area, George Washington National Forest, 22 June 1972, R. L. Hoffman (1), 25 June 1997, C. S. Hobson & M. Hayslett (1). *Rockingham Co.*: Tomahawk Mountain, ca. 7 mi NNW of Rawley Springs, 17 June 1988, K. A. Buhlmann (14).

While the majority of these specimens are dull metallic dark green, the elytra of several are a prominent reddish-purple to bronzy cast. The two specimens from Locust Springs differ from the others in that the distal third of the tibiae is dusky. It will be interesting to see if this remains true in larger samples.

Anthophylax viridis LeConte

Largely sympatric with the preceding species, *A. viridis* is recorded from Quebec to Wisconsin, and south through the Appalachians to northern Georgia although known from only a few sites south of Pennsylvania. Pitfall trapping in Virginia has secured only single specimens per site, against much greater numbers of *A. cyaneus*.

Augusta Co.: Shenandoah Mountain, pitfall site off FS 85, 3 mi. S jct. FS 95, 17 June 1988, K. A. Buhlmann (1). *Rockbridge Co.*: Petite's Gap, jct. Blue Ridge Parkway and FS 35, 5 June 1996, M. W. Donahue (1). *Rockingham Co.:* pitfall site off FS 72, Tomahawk Mountain, ca. 7 mi. (airline) NW of Rawley Springs, 17 June 1988, K. A. Buhlmann (1).

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Banisteria, Number 22, 2003

New Flea and Cimicid Records from Birds in Virginia

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INTRODUCTION

Ten species of fleas (Order Siphonaptera) are found on birds in eastern North America (Traub et al., 1983). Currently, only two species, *Ceratophyllus styx riparius* Jordan and Rothschild, 1920 with records from nests of Bank Swallows (*Riparia riparia*) from Rosslyn, Fairfax County, Virginia (Jordan, 1929) and *Ceratophyllus idius* Jordan and Rothschild, 1920 with two records from Purple Martins (*Progne subis*) from the coast of Virginia (Benton,1980) are known to occur in Virginia. Most bird fleas are parasites of swallows, cavity or ground-nesting birds, and their nests (Traub et al., 1983). There is a growing literature to document that ectoparasites such as fleas (Brown & Brown, 1986; Dufva & Allander, 1996; Kedra et al., 1996; Rytkonen et al., 1998; Merino et al., 1999), ticks (King et al., 1977), and mites (Moller, 1990; Merino & Potti, 1995) have adverse effects on the health and reproductive success of birds. However, there is no evidence that cimicids called swallow bugs (Order Hemiptera) transmit any infectious agents to birds, but the blood loss they cause may be debilitating. Herein, we report one new flea and one cimicid record for the state of Virginia.

MATERIALS AND METHODS

Abandoned nests were collected in the field from bird boxes, trees, under bridges, and in cavities in riverbanks from numerous localities in Virginia from May 1984 to August 2001. Collections were chiefly random but included localities from all physiographic provinces of Virginia. Three Eastern Bluebird (*Sialia sialis*) nestbox "lines" were sampled intensively. In 1995, 28 nestboxes were monitored from May to August at Huntley Meadows Park, Fairfax County, VA. On 27 February 1999, nests from 48 bluebird boxes were collected at the Smithsonian Institution Center for Research and Conservation, Front Royal, Warren County, VA. In the summer of 2001 a total of 315 nests from bluebird boxes was sampled from the counties of Fauquier, Loudoun, and Prince William in northern Virginia. The 2001 samples included nests of 149 Eastern Bluebirds, 74 House Sparrows (*Passer domesticus*), 55 Tree Swallows (*Tachycineta bicolor*), 11 European Starlings (*Sturnus vulgaris*), and 26 miscellaneous others. Most nests were collected soon after the young birds had fledged. The nests were placed in plastic bags individually with collection data noted. A very few nests had a moist paper towel added to the bag; the towel was examined for several days to detect possible emerging adult fleas but none was found. Most nests were placed in a Berlese funnel as soon as possible. The funnel was operated for 24-48 h and the parasites were collected in 70% ethanol. Cimicids were picked out of the nest fragments with forceps and preserved in 70% ethanol. All fleas and some of the swallow bugs were decolorized in 10% KOH, dehydrated in ethanol, cleared in xylene, and mounted on slides in Canada balsam. Vouchers have been deposited in the collections of the Virginia Museum of Natural History (accession number 2000-079) and in the collection of the authors. Bird names follow the AOU checklist (1998).

[1] Deceased

RESULTS

Five hundred forty-seven nests of 24 known species of birds and nine nests of unknown species were examined (Table 1). Four nests contained fleas whose normal hosts are birds (0.7%) but eight (1.4%) had mouse fleas, *Orchopeas leucopus* (Baker, 1904). The latter included four Barn Swallow nests from Highland County (n = 1, 4, 6, and 7 fleas) and four Eastern Bluebird nests from Fauquier (n = 3 and 11), Prince William (n = 1), and Warren (n = 4) counties. One Bank Swallow nest contained 45 mouse fleas *Epitedia wenmanni* (Rothschild, 1904). Four nests (0.7%) had the squirrel flea, *Orchopeas howardi* (Baker, 1895), including two Field Sparrow (*Spizella pusilla*) nests from Loudoun Co. (one flea each) and bluebird nests from Fauquier (n = 14 fleas) and Loudoun (n = 1) counties. Two additional nests contained both mouse and squirrel fleas: a Field Sparrow nest from Loudoun Co. contained 37 *O. howardi* and one *E. wenmanni*, and a bluebird nest from Prince William Co. had two *O. howardi* and one *O. leucopus*.

The four nests with bird fleas were one Purple Martin with 98 *Ceratophyllus idius* (VA, Accomack Co., Chincoteague, 28 September 1985); one Tree Swallow with three *C. idius* (VA, Warren Co., Front Royal, 27 February 1999); and two Cliff Swallow (*Hirundo pyrrhonota*) nests (both VA, Louisa Co., Bumpass, 21 November 1992) with 11 and 20 *Ceratophyllus celsus celsus* Jordan, 1926. The same two Cliff Swallow nests from the Bumpass site also yielded hundreds of adults and nymphs of the swallow bug *Oeciacus vicarius* Horvath, 1912, (Insecta: Cimicidae).

Table 1. List of the bird nests examined for bird fleas and swallow bugs in Virginia.

Family	Species	Nests examined	Number of Parasites
Anatidae	Wood Duck (*Aix sponsa*)	3	0
Tyrannidae	Eastern Phoebe (*Sayornis phoebe*)	28	0
Hirundinidae	Purple Martin (*Progne subis*)	2	98 *Ceratophyllus idius*
	Tree Swallow (*Tachycineta bicolor*)	75	3 *Ceratophyllus idius*
	Cliff Swallow (*Hirundo pyrrhonota*)	7	11 *Ceratophyllus celsus*
			20 *Ceratophyllus celsus*
			many *Oeciacus vicarius*
	Barn Swallow (*Hirundo rustica*)	61	0
	Bank Swallow (*Riparia riparia*)	3	0
Paridae	Carolina Chickadee (*Poecile carolinensis*)	11	0
	Tufted Titmouse (*Baeolophus bicolor*)	5	0
Sittidae	White-breasted Nuthatch (*Sitta carolinensis*)	1	0
Troglodytidae	Carolina Wren (*Thryothorus ludovicianus*)	4	0
	House Wren (*Troglodytes aedon*)	18	0
Sylviidae	Blue-gray Gnatcatcher (*Polioptila caerulea*)	1	0
Turdidae	American Robin (*Turdus migratorius*)	7	0
	Eastern Bluebird (*Sialia sialis*)	204	0
Mimidae	Northern Mockingbird (*Mimus polyglottos*)	1	0
Sturnidae	European Starling (*Sturnus vulgaris*)	11	0
Parulidae	Yellow Warbler (*Dendroica petechia*)	3	0
Emberizidae	Chipping Sparrow (*Spizella passerina*)	5	0
	Field Sparrow (*Spizella pusilla*)	4	0
Cardinalidae	Northern Cardinal (*Cardinalis cardinalis*)	3	0
Icteridae	Red-winged Blackbird (*Agelaius phoeniceus*)	6	0
Fringillidae	House Finch (*Carpodacus mexicanus*)	2	0
Passeridae	House Sparrow (*Passer domesticus*)	82	0
Unidentified birds		9	0
TOTAL		556	4

DISCUSSION

Relatively few records exist for bird fleas (Benton & Shatrau, 1965) and swallow bugs (Usinger, 1966) from eastern North America. *Ceratophyllus idius* is a parasite of tree swallows, martins, and bluebirds, species that use birdhouses. One would think that they would be well collected, yet Benton (1980) listed only 39 localities in eastern United States. Holland (1985) added 10 additional sites from Ontario, Quebec, New Brunswick, and Newfoundland in Canada. We collected our specimens in September from an abandoned Purple Martin apartment house and in February from an unoccupied bluebird box containing the typical nest of a Tree Swallow. This species is probably more common and widespread in Virginia than is now known.

Ceratophyllus c. celsus is a true parasite of the Cliff Swallow. It ranges from Alaska to New Brunswick and south to Texas, but there are few records for eastern North America. Holland (1985) listed 10 records for Quebec, Ontario, and New Brunswick in Canada; Galloway (1987) reported 10 additional sites from Ontario. There are only seven reported collections in the eastern United States from Illinois (2), Michigan (1), New York (3), and Vermont (1) (Benton, 1980). The Virginia record is the southernmost. In eastern North America *C. celsus* is the only member of the genus *Ceratophyllus* found in Cliff Swallow nests. In western North America it is replaced by *Ceratophyllus petrochelidoni* Wagner, 1936 and *Ceratophyllus scopulorum* Holland, 1952 (Pilgrim & Galloway, 2000). The domed Cliff Swallow nests that were infested were collected under a bridge spanning an arm of Lake Anna. Within a meter of the Cliff Swallow nests were located Barn Swallow nests. The latter contained no fleas or swallow bugs.

Although *Oeciacus vicarius* is very common in Cliff Swallow nests in western United States, there are only a few records from New England and New York in the East (Usinger, 1966). This species has not previously been reported from Virginia. The Bumpass locality is the southernmost occurrence east of the Mississippi River. All stages of the parasite overwinter in unoccupied nests; populations in Oklahoma were observed to peak in late summer (August-September) (Loye & Hopla, 1983). Barn Swallows and Bank Swallows are other known hosts and Usinger (1966) stated that in California, every Cliff Swallow nest that he examined was infested.

From our data we conclude that bird fleas are relatively uncommon in Virginia because only 0.7% of the 556 nests examined were infested. This is probably true because this is the southern limit of geographic distribution for most species of bird fleas. It is also apparent that mice and squirrels visit and use bird boxes and bird nests and leave their fleas behind.

Bird fanciers who maintain nest boxes for Eastern Bluebirds and Purple Martins could make a contribution to the knowledge of distribution of these parasites by submitting parasites found in the nests or on birds to the authors or to the Virginia Museum of Natural History for identification. Placing the parasites in a plastic bag containing a paper towel soaked in rubbing alcohol, with collection data indicating species of the host or nest, state, county, town, date, and name of collector would assure maximum value of the collection. Even the larvae of swallow fleas preserved in alcohol are identifiable now thanks to a key produced by Pilgrim & Galloway (2000).

ACKNOWLEDGMENTS

We thank numerous personnel and volunteers from the Smithsonian Institution Center for Research and Conservation in Front Royal, Virginia, and those at the Huntley Meadows Park in Alexandria, Virginia who collected nests for us. Bob and Maryellen Gargus of Bumpass, Virginia provided the boat that enabled us to collect nests from under bridges. Walter Bulmer helped associate some of the abandoned nests with a bird species. Richard Hoffman and Michael Kosztarab searched the collections of the Virginia Museum of Natural History in Martinsville and Blacksburg, respectively, for previous Virginia records of the swallow bug. Nests were salvaged under permits from the Virginia Department of Game and Inland Fisheries.

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Shorter Contributions

Banisteria, Number 22, 2003

UNUSUAL FORAGING BEHAVIOR OF A YELLOW-BILLED CUCKOO ON ASSATEAGUE ISLAND, VIRGINIA -- On 1 August 2002, I observed an unusual feeding behavior of an immature Yellow-billed Cuckoo (*Coccyzus americanus*) (age evident by absence of yellow in the bill and presence of large white spots on the undertail) on the Woodland Trail of the Chincoteague National Wildlife Refuge on Assateague Island. At about 1700 h, a cuckoo flew onto the branch of a deciduous tree at a height of about 7 m, just above a large Eastern Tent Caterpillar (*Malacosoma americana*) nest > 0.3 m in length. The cuckoo inched along the branch until it was directly over the nest which hung below the branch. It spent approximately 1 min visually inspecting the nest, likely waiting for potential prey to indicate its presence by moving (Hamilton & Hamilton, 1965). It then stretched its body forward apparently trying to obtain a prey item (Bender, 1961). It made two attempts in this way to extract prey but failed both times. It then jumped into the nest from above. It is not clear if the bird jumped through an opening or penetrated the wall of the nest. The cuckoo emerged with a 2.5 cm caterpillar in its bill within several seconds after it jumped. It also reemerged without any nest material covering its body and flew off almost immediately after capturing its prey.

Tent caterpillars weave nests that are closed to protect them from birds and insects (Rabaglia & Twardus, 1990). They are, nevertheless, vulnerable to foraging birds penetrating the nest to gain access. Bent (1940) described an instance of Yellow-billed Cuckoos tearing up a number of these nests in half a day. In view of the fact that the juvenile emerged from the nest without any of the nest material visible on its plumage, it is possible that either it or the adults or both had previously visited this nest and had already created an opening in the tent so that there was access to prey.

Although tent caterpillars are among the favored prey of Yellow-billed Cuckoos (Hughes, 1999), this foraging technique has not previously been reported in the literature on the species. Its most common foraging technique is gleaning insects from leaves and stems, typically while perched, but sometimes while hovering (Hughes, 1999). "Jumping" as a means of attacking prey is not a standard foraging behavior employed by non-raptorial landbirds using terrestrial habitats nor is it among the rare foraging maneuvers previously described for this group of birds (Remsen & Robinson, 1990). Silver Gulls (*Larus novaehollandiae*) use "jump-grabs" as one of several methods for stealing food from Crested Terns (*Sterna bergii*) in Australia. A ground-attacking gull jumps at a low-flying tern in an effort to grab a fish the tern is carrying in its bill (Hulsman, 1984). Likely, the cuckoo was able to capture a prey item by jumping into the nest, perching briefly, and then snatching a larva with its bill.

That an immature bird engaged in this aberrant behavior may reflect its relative inexperience in foraging. The caterpillar nest material represented a potential threat to the bird if it adhered to its plumage and diminished its capacity for flight. Damaged feathers have been shown to affect adversely the capacity for escape in European Starlings (*Sturnus vulgaris*) (Swaddle et al., 1996). Presumably the bird would not have endangered itself by getting tent material on its plumage, although a young bird may not have been able to assess the risks.

ACKNOWLEDGMENTS

I thank Caleb Gordon, Anne Houde, and Jeffrey Sundberg for their comments on an earlier version of this paper, Tim Morton for informing me about tent caterpillar behavior, and Richard Roberts for information about Yellow-billed Cuckoos breeding on Chincoteague NWR.

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Banisteria, Number 22, 2003

HEILIPUS APIATUS, A STRIKING LARGE WEEVIL NEW TO THE VIRGINIA FAUNA (COLEOPTERA: CURCULIONIDAE)--Collecting beetles for the Virginia Museum of Natural History at First Landing (formerly Seashore) State Park, City of Virginia Beach, during the period of 23 June-7 July 2003, Robert Vigneault obtained three specimens of a large black weevil with extensive white elytral ornamentation. Another specimen from the same locality, collected by Kurt A. Buhlmann of the Virginia Natural Heritage Program in 1989, was found among unidentified material in the VMNH beetle collection.

Reference to the antique but still indispensable manual on the weevils of eastern North America (Blatchley & Leng, 1916) led to identification of the beetle as *Heilipus apiatus* (Olivier, 1807). As evident from the photograph (Fig. 1), this is a stately and impressive insect, unlikely to be mistaken for anything else, and in fact, there are no close relatives in North America although the genus is extravagantly represented by at least 328 nominal species in the Neotropical Region (Blackwelder, 1947).

Blatchley & Leng (1916) mentioned Florida, Tennessee, and Georgia as known states of record. More recent sources have added Florence and Walterboro, South Carolina (Kirk, 1969, 1970), and Raleigh, Windsor, and Southern Pines, North Carolina (Brimley, 1938); both of these authors used the junior synonym *Heilipus squamosus* LeConte.

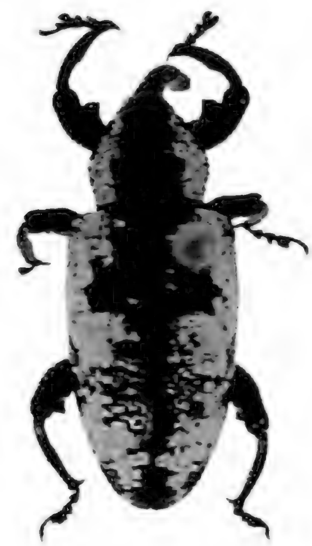

Fig. 1. *Heilipus apiatus* from First Landing State Park, City of Virginia Beach; body length = 14 mm (from base of beak to elytral apex) (photograph by Melody Cartwright, VMNH).

Pin label data for North Carolina specimens in the North Carolina State University insect collection (kindly provided by Robert L. Blinn) reflect captures in the following counties and years: Bertie (1934), Brunswick (1954), Craven (1907), Dare (1961), Johnston (1976), Tyrell (1975), and Wake (1938). That these sites are all in the Coastal Plain is not surprising, a more interesting aspect of the data is the fact that no specimens of this large and conspicuous beetle have found their way into that collection since 1976. From the analogy of various other insects with austral distributions that have achieved dramatic northward dispersal in recent decades, one might have suspected that *H. apiatus* would likewise be responding to an apparent "global warming" episode. Just the opposite may have taken place, with the range currently in a state of fragmentation.

In Florida *H. apiatus* is considered a pest on cultivated avocados (Woodruff, 1963). Elsewhere it has been found on sassafras (*Sassafras albidum*) (Blatchley & Leng, 1916), a species in the same family (Lauraceae) that is widespread over most of eastern North America. The distinctly lowland distribution of *H. apiatus* is thus possibly a reflection of some environmental constraints other than host availability, unless, as suggested to me by Warren E. Steiner, the

preferred host might actually be redbay (*Persea borbonia),* a species of Lauraceae with a distribution encompassed by that of *H. apiatus.* One of Mr. Vigneault's specimens came to an ultraviolet light, the others were taken by beating undetermined woody plants, which could have included sassafras or redbay, both common at Virginia Beach. Dr. Buhlmann's specimen was taken in a pitfall trap during the period of 3 August-8 September 1989, establishing a summer-long activity period. That the species occurs as far inland as Raleigh implies a Virginia distribution more extensive than our single locality might suggest. Perhaps collecting efforts focused on the two tree species mentioned above may yield additional information on this interesting beetle.

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Banisteria, Number 22, 2003

PELAGE ANOMALY IN A NORTHERN SHORT-TAILED SHREW, *BLARINA BREVICAUDA*, FROM WEST VIRGINIA -- Pure albinism is rare in insectivores; however, albinism, white spotting or belting has been documented for masked shrews (*Sorex cinereus*), dusky shrews (*Sorex obscurus*), least shrews (*Cryptotis parva*), and northern short-tailed shrews (*Blarina brevicauda*) (Hamilton, 1939; Elder, 1960; Brooks & Doyle, 1994; Long & Gehring, 1995; Moncrief & Anderson, 1997; Bumann & Scanlon, 2002; S. McLaren, pers. comm.). Older short-tailed shrews often display white hairs infrequently throughout the pelage or they may be concentrated into dime-sized spots near the flanks (Hamilton, 1939). Twelve short-tailed shrews with pelage anomalies have been documented in Pennsylvania, most with a single or few white spots (S. McLaren, pers. comm.). Most of these animals were captured over 50 years ago, and only two have been taken in the last 25 years. One of these two was a pure albino short-tailed shrew collected at Powdermill Biological Station, ca. 100 km southeast of Pittsburgh, Pennsylvania. In over 43,000 captures in that project, this was the only short-tailed shrew with a white pelage; no partial albinos were captured (J. Merritt, pers. comm.).

We captured a northern short-tailed shrew (*Blarina brevicauda*) with partially white pelage. The specimen was captured in a pitfall on 30 May 2001 in a wetland located in the Monongahela National Forest in Tucker Co., West Virginia (39.07238° N; 79.473078° W, ca. 1114 m). The dry pitfall trap was a 964-cm^3 plastic drink cup set flush in the ground. The vegetation in this acidic (pH range: 3.3-5.5) shrub-bog was dominated by groundberry (*Rubus* spp.), black chokeberry (*Pyrus melanocarpa*), blueberry (*Vaccinium* spp.), *Polytrichum* moss, and *Sphagnum* moss.

The specimen weighed 11.0 g, and was identified as a non-lactating female. She had a partial white band, ca. 8 x 15 mm, on the right side, about halfway between the forelegs and hindlegs (Fig. 1). It was photographed and released near the capture point. This specimen was one of 30 northern short-tailed shrews captured in five nights of trapping at this site (1875 trap-nights) using pitfalls, Sherman live traps, and Museum Special snap-traps. We captured 198 northern short-tailed shrews at 19 additional wetland sites in West Virginia and western Maryland in 2001; all exhibited normal pelage coloration.

Through inquiry to regional natural history museums, we note that our capture is the only the second recorded pelage anomaly for northern short-tailed shrews in West Virginia. Another specimen with several white spots was captured in 1985 in Pocahontas County, in the Cranberry Back Country of the Monongahela National Forest (S. McLaren, pers. comm.).

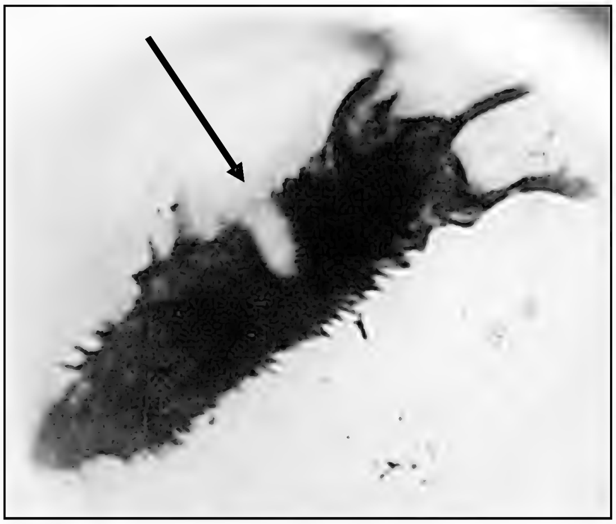

Fig. 1. Live northern short-tailed shrew (*Blarina brevicauda*) from West Virginia with a white pelage anomaly (arrow).

ACKNOWLEDGMENTS

We thank S. McLaren (Carnegie Museum of Natural History, Pittsburgh, PA), J. Merritt (Powdermill Biological Station, Rector, PA), N. Castleberry (West Virginia University), M.E. Hight (Marshall University), and E. McGhee (Georgia Museum of Natural History) for checking the collections of their respective institutions for *B. brevicauda* with abnormal pelage conditions. Additionally, we thank S. Dumpert, R. Kotecki, and H. Hadley for assistance in the field.

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Book Reviews

Birds of the Mid-Atlantic Region and Where to Find Them by John H. Rappole. 2002. Johns Hopkins University Press, Baltimore, MD. 427 pp. $49.95 hardcover, $21.95 paperback.

The proliferation of birding field guides has resulted in an overwhelming number of book choices for beginning and experienced birders. Currently, a bookstore may carry a dozen or more North American bird books, ranging from beginners' guides that feature a limited number of common species, to comprehensive guides with the most recent and thorough understanding of field identification techniques. Then, when a birder wants to learn more about what sites to visit when traveling to Virginia or the greater Mid-Atlantic region in the hopes of seeing unfamiliar species, there is an additional number of site guides to choose from. Or perhaps someone in the Mid-Atlantic region new to birding desires a book that has narrowed the list of birds to only those that occur locally, and provides locations to see them as well. So, like a species in a crowded environment wedging itself into an ecological niche, *Birds of the Mid-Atlantic Region* looks to appeal to the birder and naturalist by distilling this myriad of information into a smaller and more manageable regional context, and combining a field guide with site information into one volume. Distinguished ornithologist John Rappole of the Smithsonian Institution's Conservation and Research Center in Front Royal, Virginia, has authored this volume that is a field guide to nearly all birds (except for casual, extinct, and accidental species) reported for our region, while at the same time including occurrence status and site suggestions. The book includes only those avian species that occur in the Mid-Atlantic states of Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia. This is still a considerable 346 species, but is less than, for example, the 508 species described in the Audubon Field Guide: Eastern Region (Bull & Farrand, 1994), and is considerably fewer than the 810 species treated by Sibley (2000) for all of North America.

Birds of the Mid-Atlantic Region opens with a regional introduction including local ornithological history, climate, and habitat descriptions illustrated with photographs. Helpful to inexperienced birders is a two-page "Quick Guide" with photos of 33 common species. A birding sites locator gives numerous site descriptions with driving directions for each state, including nearly sixty in Virginia. I would agree with nearly all of these choices, but would have added Henricus Park/Dutch Gap Conservation Area in Chesterfield County, Virginia because of its accessibility and observability of so many species. I would have omitted Presquile National Wildlife Refuge (PNWR), which is later listed as the recommended site for Summer Tanager in Virginia. Unfortunately, this refuge has been inaccessible to the public since March 2001 when the cable ferry was condemned as unsafe. Future plans are to acquire a pontoon boat, but if and when this happens, the refuge will still require at least one week's notice for visitation due to a lack of on-site staff (PNWR staff, pers. comm.). Perhaps communication with local reviewers could have eliminated problems such as this. In the Acknowledgments there is no indication that the manuscript was submitted for local comments. I would have been happy to point instead to nearby and easily accessible Pocahontas State Park (listed in the site guide) for Summer Tanager, where this species is common in its preferred habitat of dry pine/oak woods (as opposed to the swampy riparian woods of PNWR). The closing date for PNWR (March 2001) and the publication date of this book (December 2002) might have prevented this update anyway, but this oversight is an example of the major problem I have with *Birds of the Mid-Atlantic Region*. No one person can be up to date on the changing status of species occurrences and site recommendations for such a multi-state area. I think input from local field ornithologists is essential for a volume such as this, and would have helped give a more accurate presentation.

For instance, I strongly disagree with the site recommendation for Virginia of James River Park in Richmond for Evening Grosbeak. I bird this area regularly and have participated since 1985 in the informal James River Park bird count in January. This bird count has never recorded Evening Grosbeak, and I am not aware of any sight records there for the species in at least ten years. Perhaps this recommendation was based on Johnston (1997), but the inclusion of Evening Grosbeak for James River Park in that site guide was already dated. I would have suggested "feeders in Highland County", or better yet, left out a Virginia site entirely so as not to mislead the reader. Not every state has a site listed for each potential species, and a site should be indicated only if there is a reasonable possibility of seeing the species. I was mystified as to why there was no site listed for Virginia for Acadian Flycatcher, a bird which can be found easily in the

state. Conversely, there are sites listed (Mount Rogers) for both the Olive-sided and Yellow-bellied Flycatchers, but they no longer occur there as breeding species, or reliably anywhere else in Virginia.

Each species is illustrated by a single photograph approximately 1.5 x 1.75 inches. The quality of the photos and reproduction is excellent, but a single photo only illustrates a single sex and/or plumage. Most photographs are of males, though not always (e.g., Red-breasted Merganser). A substantial limitation of this book as a complete field guide is apparent in examples of common, sexually dimorphic species such as House Finch, Scarlet Tanager, and Northern Cardinal, where only the male is illustrated. Another limitation of one photo per species is what plumage to choose. For instance, the Horned Grebe is illustrated in winter plumage, which is predominantly what we see in the Mid-Atlantic, but the photo of the Lapland Longspur is of a breeding plumaged male. This species is rarely, if ever, seen in breeding plumage here and I think it should have been illustrated in winter plumage.

I would also argue with some of the species included in the main species accounts. Common Ground-Dove is included based on its occurrence in Virginia only. But this species practically no longer occurs here and the last sighting in Virginia that I am aware of was a hurricane-assisted bird in 1996. Common Ground-Dove has declined considerably in the southeast and should have been relegated to the Appendix of "Hypothetical, Casual, Accidental, and Extinct Species." Likewise, the Fulvous Whistling-Duck and Purple Gallinule are very seldom reported. A visiting birder has virtually no chance of seeing these species. However, Mississippi Kite (listed only in the Appendix) does have a breeding population in southern Virginia, and they are annual in northern Virginia. Rufous Hummingbird is increasingly common in winter at feeders and is widely present and reported annually. A visiting birder can make an effort similar to that required to find, say, a Swainson's Warbler, and have a good shot at seeing either the kite or the hummingbird in Virginia. These two species should have been included in the species accounts instead.

Despite these problems, the book is basically a useful reference for someone needing a general overview of occurrence and site suggestions for the region. Even though the *raison d'etre* of this book is to eliminate the need of the user for a series of books, I would only recommend using this book in conjunction with more specific and recent field and site guide information. My personal habit is to use a variety of references, and I would recommend *Birds of the Mid-Atlantic Region* as a middle ground between more comprehensive national and detailed local information.

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The Natural History of the Great Dismal Swamp, edited by Robert K. Rose. 2000. Suffolk-Nansemond Chapter, Izaak Walton League of America, Inc., Suffolk, VA. 300 pp. Available for $30.00, plus $5.00 postage, from Suffolk-Nansemond Chapter, Izaak Walton League of America, Inc., P. O. Box 349, Suffolk, VA 23439-0349.

Almost sixty years ago, two college-age amateur herpetologists embarked on an ambitious, if somewhat quixotic, project to survey the amphibian and reptile faunas of the "Dismal Swamp Region", defined as all of the territory between the James and Chowan estuaries and east of the Suffolk escarpment. A respectable fulfillment of this intention was of course far beyond their ability, and to their credit -- after making several collecting trips to the area, and canvassing museum collections for relevant records -- they had sense enough to realize the magnitude of the task and abandon it in favor of attainable pursuits. Nonetheless, one of them (the present reviewer) was sufficiently intrigued by the natural history of extreme southeastern Virginia to maintain an ongoing interest in the Dismal Swamp, conducting a number of collecting trips into and around it during subsequent decades and following with interest the activities of other investigators.

Since 1947, the Swamp has attracted the attention of numerous naturalists who have built upon the foundation laid down much earlier by such pioneer investigators as Jordan, Shaler, Merriam, and Fisher. Despite the long history of exploitation, mismanagement, and abuse to which it has been subjected (the term "dismal" applies most aptly to the results of human impact), with alteration of most local ecosystems, much of the pre-Colonial environment

remains as a reservoir of the biotas that sequentially occupied the swamp through several climatically induced ebbs and flows.

The first attempt at a synthesis of investigations of the Swamp was produced under the aegis of the Virginia Academy of Science (Kirk, 1979), a volume which embodied both the achievements and deficiencies of any pioneering effort. Unquestionably, it catalyzed the research of another generation of scientists, many of them based at Old Dominion University, and so led more or less directly to a subsequent summary of our knowledge in the book that is the subject of this review.

The Natural History of the Great Dismal Swamp is the outcome of a symposium convened in January 1997 at Old Dominion University with the support of the Izaak Walton League and concerned elements of the private sector. Edited by Dr. Robert Rose of ODU, one of the organizers, it contains 25 papers presented at that meeting as well as three additional contributions received at a later date. The 28 chapters embrace a spectrum of subjects ranging from historical accounts to summaries of large taxa of organisms to management of the refuge and its megafauna. It is a characteristic of most symposia of this kind that coverage is inevitably opportunistic and eclectic, reflecting which specialists can be recruited to participate, and the relative maturity of the particular aspects of "natural history" which are addressed. Some papers are about as conclusive as can be wished, others represent little more than glimpses through a dark glass. In terms of taxon inventories, only four chapters achieve any degree of completeness, collectively treating perhaps 5% of the actual existing biota. On this basis, the title of the book is far more pretentious than the contents justify. A more precise title might have begun with the words "Contributions to the. . ." or "Aspects of the. . .".

I found the initial contributions to be of particular interest. Chapters 1 and 2 reconstruct the long and complex saga leading to establishment of the present National Wildlife Refuge, and serve as a sort of casebook study of how much is required of how many people (representing public, governmental, and private sector interests) in order to accomplish a large-scale environmental *tour de force*. Chapters 3 and 4 provide a good impression of conditions on the site during the time period recorded in the field notes of three federal biologists (Merriam, Fisher, and Preble) who collected in the Swamp for the U. S. Biological Survey in the 1890s, and explain how they happened to be there.

Subsequent chapters treat aspects of the Swamp's environment: physical features, past history, and imminent dangers of Lake Drummond; plankton studies, community descriptions, autecology of Atlantic white cedar stands, and ethnobotany. I pass over these informative contributions in favor of a closer look at the ten chapters devoted to taxon surveys. Only one of these is botanical in nature: a survey of the fern genus *Dryopteris*, for which the Swamp is a hot spot of diversity and hybridization.

The four vertebrate classes command six of the nine chapters devoted to animal life, two of them for birds and two for small mammals. It is not surprising that vertebrates are relatively well-known, a historical fact going back two centuries, compared to other phyla. Thirty-two species of fishes, four of them introductions, have been documented since D. S. Jordan made the first collections in 1888. This small number, dominated by small centrarchids, appears to be the result of dark-colored, acidic water for which the swamp has long been famous but not esteemed by various aquatic animals. The species accounts in this chapter include information on the dynamics of local occurrence as well as the Swamp in context of overall species' ranges.

Amphibians and reptiles contribute 65 species confirmed for the "Dismal Swamp watershed". Adherence to this hydrographic definition excludes several additional species known from sites within a few kilometers in Chesapeake and Virginia Beach cities, Virginia, and which can be considered residents so far uncollected, so that an actual count of well over 70 species may be reasonably expected. Species accounts in this chapter range from brief and perfunctory for common forms to fairly detailed treatments of individual captures and biological information for the less common. The chapter closes with a biogeographically-oriented summary and an appeal for more detailed local studies and, especially, more effective measures for conservation of the swamp's biota and protection against destruction of habitats peripheral to the Refuge itself.

Birds are treated in two chapters: one documents observed changes in the avifauna over the past several decades, noting in particular that 42 species have been added to the local faunal list since the 1974 symposium, owing largely to increased activity by local amateur ornithologists. The second reports a detailed population study of the breeding bird species in two local Atlantic white cedar stands, and contrasts these faunas with those of adjacent maple/gum stands.

Small mammals are discussed in two chapters, one for the 12 kinds of bats, another for 14 nonvolants small enough to fit into a human hand. Larger species get short shrift, aside passing mention in chapters 3 and 23. One author noted that the black bear is the region's most notable mammal, and this seems borne out by the dedication of Chapters 21 and 22 to the status and management of this one species.

One concluding chapter (26) tabulates records for amphibians, reptiles, and mammals accumulated over a 25-year period at a single locality on the eastern edge of Lake Drummond. While the results reflect the documentation of many species for a single site, there are some interesting points embedded in the tabular presentations, apparently evading the attention of reviewers. The nomenclature of several species is not current (e.g., *Eurycea bislineata* is in error for *E. cirrigera*, *Plethodon glutinosus* for *P. chlorobryonis*, and *Hyla versicolor* for *H. chrysoscelis*). *Ambystoma maculatum* is listed as "common" although there are no verified records for the species east of the Blackwater River, and the statement is made in Chapter 17, relative to *A. opacum*, that "no other ambystomatid occurs in this area." This is a puzzling situation, since the species is surely one of the most distinctive and easy to recognize salamanders in Virginia. Another problem pertains to the status of what is listed as *Pseudacris triseriata*, another amphibian not listed in Chapter 17 nor verified anywhere for the Swamp area. In the absence of preserved voucher specimens, resolution of these two problems may require recollecting at the same site, or perhaps examination of the photographs stated on page 255 of this chapter made "of all specimens" would be conclusive.

Chapters 12-15 survey different groups of arthropods, with varying degrees of thoroughness. The odonates and butterflies are, for insects, now relatively well-known, and their coverage is comprehensive and detailed, presented in tabular as well as narrative form that includes a biogeographically-oriented summary for each group. In contrast, present knowledge of spiders is still in its infancy and the present baseline of 56 species reflects the hand-capture of mostly "above-ground" species. Future inventories that employ a range of collecting techniques in many different biotopes and throughout the year will surely increase the number of resident spiders to as many as 500 species. Chapter 14 discusses a variety of aquatic "macroinvertebrates" found in the drainage ditches in a quantitative context relative to water chemistry, but carries the analyses only down to the level of family.

As regards production values, the book is attractive and appears to be sturdily bound. The glossy front cover is decorated with nine color photographs, which are also reproduced as chapter frontispieces in black and white. The page layout is in two columns, in what appears to be a 10-point serif typeface, on a good quality paper with no show-through. Each chapter begins on an odd numbered page, and most are preceded by a page-sized photograph. Interestingly, there are no center headings in the book, and the side headings are in an obtrusive block capital boldface which in my opinion is not harmonic with the type font of the text. There is an adequate "general index" and another for all of the organisms that intercalates vernacular and scientific names. The full-page photographs that introduce many of the chapters are usually relevant to what follows, occasionally they seem misplaced (e.g., the spider on page 132 would have been better placed facing page 139, where the account of spiders begins). At least one is sensational: the person shown on page 260 prodding a large bear with a stick is either superbly qualified to know what he is doing, or hasn't the slightest idea of possible ursine responses. The reader is left to ponder the outcome. Was another photograph made 30 seconds later?

I am not a critical reader and generally do not dwell on occasional misspellings and trivial typographic errors (no amount of proof-reading ever finds them all). There are, however, some mechanical idiosyncracies throughout the book which might have been addressed with one more editorial control run, or an objective outside overview.

Firstly, there is no date of publication, and no reference to an ISBN or LC number, usually standard in all books. The running heads are the same throughout the volume, and while having the book title appear on all the even pages is appropriate, ease of reader-reference could have been enhanced by having the *chapter* title appear on the odd pages. The formatter clearly did not place a high priority on achieving columns of equal length, although this is easily accomplished by the use of line spacing during page layout. Computerized formatting seems liable to strange dislocations, and I noticed two in tabular material that are difficult to explain. In Table 1, Chapter 26, the last 18 species listed on page 256 are repeated at the top of page 257. In Table 2, Chapter 14, the three footnotes *e-g* at the bottom of page 135 are computer clones of the same three at the end of Table 1, Chapter 13, bottom of page 128. These do not, of course, detract in any way from the information presented in these tables, they are only electronic curiosities.

It has been said "If you are qualified, you write; if not qualified, you review." There is nothing easier than hindsight, and maybe reviewers should be forbidden to use it, since reviews are all *post facto* anyhow. However, in a hopeful appeal to future editors of regional biotic symposia, may I observe that I greatly regretted missing a concluding chapter that drew some inferences or generalizations from the wealth of the specific subject matter contributions. Attempting to do this myself met with indifferent success; some chapters presented generalizations, others did not. Perhaps one should also consult the facts exposed in the 1979 Dismal Swamp volume. But some of the impressions I

gained from the book under consideration here include the following:

Although many so-called "austral" organisms reach the northern limits of their current range in extreme southeastern Virginia, remarkably few do so in the Swamp itself. Far more terminate in Virginia Beach, or west of the Suffolk Scarp, or even on the outer Piedmont. The early perception that the region was a hotbed of diversification (particularly in mammals) has gradually faded, the supposedly local endemic taxa now being known from much wider ranges or now being recognizable by relatively trivial characteristics only. Even for the rapidly evolving small mammals, there has probably just not been enough time since the last marine inundation of eastern Virginia to allow much notable change. Perhaps the Dismal Swamp is most remarkable for being the northernmost of the great southern swamps, and the concomittant occupancy by black bears in the Atlantic Coastal Plain (at the present; surely they were widespread in pre-Colonial days).

While the biota of the Swamp does contain a substantial number of lower Austral elements, which have apparently occupied the region since the fairly recent period when it was a boreal evergreen forest, an equally interesting contingent is made up of currently northern species which exist there (and elsewhere in the Coastal Plain) as disjunct boreal relicts. The lemming vole (*Synaptomys cooperi*) is a mammalian element, perhaps the dragonfly *Sympetrum janeae* is another. Caddisflies (so far not itemized for the Swamp) provide additional examples. The emphasis placed on vertebrates in both the 1979 and 2000 volumes might mandate orientation of a future symposium - and book - toward the arthropod fauna, so far scarcely touched, which doubtless makes up 90% of the biota of the Swamp as it does elsewhere, and surely contains a treasury of valuable biogeographic information not manifest by the handful of vertebrates. Of course, such a redirection of attention would presuppose the initiation of extensive and prolonged inventory programs, followed by the analysis of thousands of samples. Such a commitment of resources, exacerbated by the chronic decline in the number of specialists qualified to undertake the identifications, makes it unlikely that the "natural history" of the Great Dismal Swamp will be adequately comprehended in the foreseeable future.

That this review comes three years after publication of the book is by no means a reflection of willful neglect; to the contrary it serves to remind local naturalists of a resource of ongoing usefulness. Like most symposium volumes, perhaps the major strength lies in the default presentation of what is *not* covered, and one hopes that a future compendium of this sort can address some of the still poorly-known taxa especially from a biogeographic standpoint.

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Proceedings of the Appalachian Biogeography Symposium, edited by Ralph P. Eckerlin. 1999. Special Publication Number 7, Virginia Museum of Natural History, Martinsville, VA. 257 pp. Available in soft cover only for $40.00 (Virginia residents add 4.5% sales tax), plus $5.00 shipping, from Publications Department, Virginia Museum of Natural History, 1001 Douglas Avenue, Martinsville, VA 24112; email books@vmnh.net, phone (276) 666-8600, or order online at www.vmnh.net/booksof2.htm .

In the summers of 1968-1970 and 1975, four largely independent groups of scientists and naturalists participated in a multi-year, four-part symposium at Virginia Tech on the biogeography of the Southern Appalachian Mountains. The published proceedings volumes (Holt et al., 1969, 1971; Holt & Paterson, 1970; Parker & Roane, 1976) cumulatively contain more than 1,400 pages and are generally considered classics in their respective taxonomic disciplines. Due largely to the efforts of Ralph P. Eckerlin, a biology professor at Northern Virginia Community College (and a VNHS member), a second symposium was held about a quarter-century later. A total of 35 talks was presented at this symposium which was held on 25-29 June 1995 at Virginia Tech. Only a handful of the 50 people in attendance also participated in the original symposium series. The 1995 symposium intermingled talks on various taxonomic groups and topics.

Proceedings of the Appalachian Biogeography Symposium consists of two very short introductory chapters and a keynote address, followed by 20 papers plus the abstracts of 14 additional presentations. It is disappointing that only 60% of the presentations resulted in published contributions. Presumably because of the long delay (four years) between the symposium and appearance of this volume, papers derived from at least three talks (Williams, 1998; Maurakis & Lipscomb, 1999; Mitchell et al., 1999) were published elsewhere prior to the proceedings; only abstracts of these talks are included in this volume.

The keynote address by Richard Hoffman is partly a personal reflection and partly an historical review of early naturalists/biogeographers of the region. This paper lacks literature citations despite frequent vague mention to various authors or references. I believe the editor should have insisted on including some (if not every) formal citations in the published version of this address for the benefit of readers who are not familiar with the references to which Hoffman alluded.

Each of the subsequent papers has an abstract and its own literature citations. Contributions vary in length from 4-20 pages, with most in the range of 10-14 pages. These papers concern animal species or communities (9 papers, including 6 on mammals and 3 on insects), plant species or communities (7), paleontology (3), and introduced tree diseases (1). The latter is essentially a summary narrative rather than an original scientific contribution. It includes a discussion of the adverse consequences on the region's forests of chestnut blight, Dutch elm disease, and dogwood anthracnose. No literature is cited in the body of this paper, but a list of references appears after the text. Topics of the various other papers range from ecology and conservation to biogeography. The latter comprise a significantly smaller percentage than the earlier series of symposia. As noted by Hoffman in his keynote address, this is partly a result of the decline in the number of taxonomists and biogeographers with intimate knowledge of their respective groups. Although they may be sound ecological studies, several papers included in this volume seem to have limited relevance to biogeography (e.g., winter habitat use by white-tailed deer, ecological characterization of a partially disturbed forest-gap bog). Unfortunately, there is no summary chapter or concluding remarks at the end of the volume, and thus apparently no attempt was made by the editor to prepare any type of synthesis of the information presented in the individual chapters.

The proceedings volume includes the description of one new species, *Litocampa condei*, a dipluran (a group of arthropods regarded either as a separate class or as a primitive order of insects). The author (Ferguson) includes an informative, biogeographic summary of Appalachian, cave-dwelling diplurans in his paper, but regrettably, the vast majority of the species are undescribed (though some were first collected decades ago) and thus they are referred to only by the genus name followed by a placeholder number.

For a volume concerning biogeography, there are surprisingly few species distribution maps. Wells' paper on the plant genus *Heuchera* is an exception, and she shows affinities of some Appalachian and western North American representatives. Steiner's paper on flightless beetles was interesting, but I had trouble convincing myself that all of his purported example species actually had disjunct distributions. The case of the two *Helops* species was the most interesting.

Holman's paper on fossil herpetofaunas is a solid contribution, but it is essentially only a synthesis of several of his previously published studies. His major conclusion is that there have been few changes in the regional fauna during the past 600,000 years. Ware's interesting paper on the historical biogeography of selected tree species, particularly their hypothesized expansions or shifts of range (including elevation) in response to Hypsithermal temperature regimes, also largely comprises a review of previous studies conducted by the author and his former students.

Three papers contain sophisticated quantitative analyses of forest tree communities, evaluating the importance of elevation, moisture, and soil nutrient levels. Three other papers concern small mammal communities (two treat shrews only) in the Appalachian Mountains, based on data from over 200 sites, including extensive use of the relatively recent technique of pitfall trapping for shrews. One of these papers discusses the high-island refugium theory and concludes that selective extinctions are largely responsible for the current distribution patterns of small mammals in the southern Appalachians. Another paper provides a good summary of the habitats and abundance of the ten shrew species in the region.

The genetic study of northern flying squirrels is essentially a progress report of a larger study involving two other rodents, and suffers from small sample sizes. Another paper summarizes the results of a comparative, 3-year study of two deer mouse (*Peromyscus*) species at Mountain Lake Biological Station in Giles County, Virginia. The abundance of both species was positively correlated with acorn abundance.

One of the last and most interesting papers in the volume discusses the role of large herbivores in maintaining grassy bald plant communities. Whereas some contend that these open, mountaintop habitats which support a number of rare and endemic species are of recent, anthropogenic origin (and hence argue against conservation of these areas through active management practices that control woody vegetation), the authors argue that many (perhaps most) of these sites had a long history of grazing by large mammals such as mammoths, mastodons, musk ox, elk, bison, and deer prior to the introduction of domestic livestock in the past few centuries. Although the flora of these habitats is relatively well documented, the fauna of most, especially the invertebrates (including those on Whitetop Mountain, Virginia), is poorly known.

Among the presentations represented by abstracts only, and not published elsewhere to my knowledge,

are the late Charles Handley's long-term (nearly half-century) study of small mammal populations near Mountain Lake and Jim Hill's work on Solitary Vireos and other songbirds in the same area. This is unfortunate because both of these essentially unpublished studies have been mentioned recently by others (Pagels, 1999; Johnston, 2000) and it would have been desirable to have completed manuscripts of both included in the symposium proceedings. The long list of Southern Blue Ridge endemic taxa (ca. 300) mentioned in Weakley's abstract would have been a useful and important contribution. The reader is left to wonder why this list could not have been included in the volume, even if accompanied by minimal text. Likewise, it is unfortunate that Bartgis' study of the distribution patterns of endemic shale barren plants is limited to a brief abstract (which is cited by at least two other authors in the volume).

This volume is only available in a paperbound edition, but it seems to be relatively sturdy and well bound. I found only a few typographical errors (e.g., it's for its, dependant, mamals) in the text and one running head. All of the papers and abstracts begin on odd-numbered pages, yielding about 25 blank pages (nearly ten percent of the volume's length). The text is presented in double column format, but in some papers there is considerable empty space because of dubious formatting decisions (e.g., some tables could have been reduced to column width; placement of figure legends beside rather than below figures, etc.). There are some minor formatting inconsistencies between the various papers (e.g., use of all caps versus title font for authors' names; variable literature citation formats), and what I consider to be poor choices in font types, rendering some text difficult to read (e.g., table of contents; authors/addresses of papers with abstracts only). The table of contents would have been much more readable if the authors' names appeared on a separate line after the title of their contribution. Perhaps the addition of a horizontal line at the end of all tables (e.g., pages 66-67) would have resulted in a more attractive layout. The quality of all beetle photographs in Steiner's paper is poor, but is this due to overexposed original images or poor reproduction by the printer? The figures in this paper are not presented in consecutive sequence. The computer-generated maps included in the flying squirrel paper were not well-suited for black and white reproduction and are difficult to read.

Despite the various problems outlined above, my general impression is that this volume contains good information and is a valuable contribution to our knowledge of the Appalachian biota. I personally doubt that it will become a classic like the earlier series of symposium proceedings, but only time can render that decision. In closing, it should be noted that three of the leading mammalogists (Charles Handley, Gordon Kirtland, and Joshua Laerm) for the Appalachian region, all of whom attended the symposium and contributed papers or abstracts, are recently deceased, leaving a large void in their field of expertise. Handley also participated in the 1970 vertebrate symposium and prepared a classic paper for that proceedings volume (Handley, 1971).

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Reports

1. **President's Report**

This year we supported the Virginia Bioblitz with $500 and wrote a proposal to the Virginia Academy of Science for funds for Bioblitz 2004. Bioblitz 2003 had about 90 participants and recorded 985 species, in spite of cold, wet weather. Art Evans has regretfully declined to head up Bioblitz next year, so hopefully one of our members will step up to the plate.

This year the VNHS distributed the new brochure with the dues notice, and asked that we all try to recruit new members. After a spirited discussion by the Council, Anne mailed out issues of *Banisteria* to members who had not renewed, and many of them did renew after receiving their complimentary copies.

At the December 2002 meeting, the Council raised the charge for back issues of *Banisteria* to $7.50 + $1.50 for postage and handling (#13, a special large issue, is $15.00 + $3.00 for postage and handling).

It has been an honor serving as President of the Virginia Natural History Society.

Respectfully submitted,
Barbara J. Abraham, President

2. Secretary/Treasurer's Report

We have 163 members, 18 of which are institutions or libraries. These are both new and renewed memberships for 2003. At the end of 2002, we also had 163 members, so it is very likely that we will gain a few more members before the end of the year.

As always, we encourage our active members to recruit members for the Society. A membership form is included with this mailing. Pass it on to a friend or colleague interested in the natural history of our state. Also with this mailing, you are receiving a renewal notice for the year 2004. Several members have paid for 2004 already!

Our treasury presently holds $6,063.39 (as of October 31, 2003). This amount includes reserves for Bioblitz for 2004 of $1,365.

We continue to be grateful to Hampden-Sydney College for support with the paperwork concerning our treasury and membership records. The secretary of Gilmer Hall, Hampden-Sydney College, Beckie Smith, has done a great job of keeping our records of membership, and she has prepared the address labels for all mailings. We thank her for her dedication to these tasks, and we thank the College for supplying this support to the Society.

Please submit all enquiries about membership in the Society or about past issues of *Banisteria* to: Dr. Anne Lund, Virginia Natural History Society, Box 62, Hampden-Sydney, Virginia 23943, or via email (alund@hsc.edu).

Respectfully submitted,
Anne Lund, Secretary/Treasurer

3. Editors' Report

The current issue of *Banisteria* (22) contains an important paper on the history of research at Mountain Lake and several papers that illustrate the diversity of topics characteristic of *Banisteria*. We appreciate the cooperation of all the authors and reviewers for helping to make this issue possible. We particularly thank Dr. Bruce Parker and The Wilderness Conservancy for their generous financial contributions in support of the publication of this issue of *Banisteria.*

We already have several manuscripts in line for the spring 2004 issue (number 23). Although we are currently experiencing a small backlog, we do not anticipate that this will create much of a submission-to-publication time delay as seen in many of the mainstream journals. Thus, we still want you to consider *Banisteria* for your papers on aspects of natural history in Virginia.

Note that the Instructions for Contributors can be viewed on the following page of the VNHS website: http://fwie.fw.vt.edu/vnhs/banis.htm. Beginning in 2004, authors of article-length manuscripts are encouraged to include abstracts and key words with their submissions. Page charges for nonmembers will increase to $15 per page.

Respectfully submitted,
Joe Mitchell and Steve Roble, Co-editors

4. **Tenth Annual Meeting of the Virginia Natural History Society**

The following eight papers were presented at the 10th Annual Joint Meeting of the Virginia Natural History Society and the Natural History and Biodiversity Section of the Virginia Academy of Science held on 30 May 2003 at the University of Virginia:

Essential oils in subterranean termite baits. L. K. Baron and D. A. Waller.

Biodiversity of mite inhabitants of the fluid-filled pitchers of *Nepenthes* in Brunei, Northern Borneo. N. J. Fashing.

Ant species collected in malaise traps in burned and unburned areas in a longleaf habitat. D. A. Waller.

An evaluation of adult freshwater mussels held in captivity at the White Sulphur Springs National Fish Hatchery. J. L. Boyles and R. J. Neves.

Occurrence of freshwater crab species (*Potamon*, *Brachyura*) relative to lotic stream factors in Greece. E. G. Maurakis, D. V. Grimes, L. McGovern, and P. J. Hogarth.

Predicting fish species diversity in lotic freshwaters of Greece. E. G. Maurakis and D. V. Grimes.

Sexual and seasonal variations of mercury in smallmouth bass (*Micropterus dolomieu*) from the South Fork of the Shenandoah River, Virginia. G. W. Murphy, T. J. Newcomb, and D. J. Orth.

Propagation and culture of endangered juvenile freshwater mussels in the Big South Fork Cumberland River. R. Mair, R. J. Neves, S. Ahlstedt, and S. Bakaletz.

Announcements

1. **Membership dues to increase in 2004**

Effective January 1, 2004, dues for membership in the VNHS will increase. This is the first dues increase since the society was formed in 1992 and is needed to offset the increased printing costs of *Banisteria.* Under the current dues structure, we simply are not bringing in enough money to allow 50-80 page issues of the journal. The basic membership rate will increase to $20 per year, family membership to $25, and the new institutional rate will be $40. The cost of all other levels of membership in VNHS remains unchanged.

2. **Back issues of *Banisteria* for sale**

Copies of all previous numbers of *Banisteria* are available for purchase from the Secretary/Treasurer, although the supply of several is nearly exhausted. Prices (including postage) are $9 for all issues except number 13 ($18). Our current supply of back issues is as follows: No. 1 (76 copies), No. 2 (104), No. 3 (83), No. 4 (61), No. 5 (11), No. 6 (133), No. 7 (1), No. 8 (46), No. 9 (7), No. 10 (38), No. 11 (17), No. 12 (38), No. 13 (21), No. 14 (23), No. 15 (4), No. 16 (40), No. 17 (14), No. 18 (37), No. 19 (16), No. 20 (45), and No. 21 (11). The table of contents of each issue can be viewed on the following page of the VNHS website: http://fwie.fw.vt.edu/vnhs/journal.htm .

3. **Former VNHS President honored**

Richard J. Neves, professor of fisheries and wildlife science at Virginia Tech, was recently awarded the Meritorious Service Award from the U.S. Department of the Interior in recognition of his outstanding contributions to the U.S. Geological Survey in the conservation of freshwater mussels in North America. Beginning in 1978, Dr. Neves established one of the first and most influential research and training programs on freshwater mussel biology and conservation. His research has documented the status of many mussel species, investigated their life cycles, fish hosts, and reproductive processes, developed laboratory-culture and hatchery techniques, and pioneered the concept of conservation refugia for imperiled species. State and federal hatcheries are now holding and propagating several endangered species of mussels using techniques and facility designs developed by Dr. Neves. He has been active in the VNHS for many years and has often published in *Banisteria*.

3. **Eleventh Annual Meeting of the Virginia Natural History Society**

The 11th Annual Joint Meeting of the Virginia Natural History Society and the Natural History and Biodiversity Section of the Virginia Academy of Science is scheduled for May 27, 2004 at Virginia Commonwealth University in Richmond. The deadline for submission of titles for presentations and posters for this session had not been set by the time this issue of *Banisteria* went to press. This information, as well as instructions for preparing and submitting abstracts of presentations, will be posted in early 2004 on the website of the Virginia Academy of Science at http://www.vacadsci.org/. Presenters must be members of the Virginia Academy of Science.

4. Inaugural Meeting of the Mid-Atlantic Chapter of the Ecological Society of America

The Mid-Atlantic Chapter of the Ecological Society of America will hold its first regional conference on March 27-28, 2004 on the campus of Franklin and Marshall College in Lancaster, Pennsylvania. The theme of the conference is "Sustainable Landscapes." Graduate and undergraduate students, and academic, government, and industry investigators from the Mid-Atlantic region are invited to share new research findings in all areas of ecology. Abstracts for posters and oral presentations may be submitted electronically until January 31, 2004 to Juliette Winterer, Chair-elect, at jwintere@fandm.edu. Oral sessions will be limited. Please include title, authors, and author affiliations with abstracts. More information on registration, housing, and program details can be found at: http://www.esa.org/MidAtlantic.

5. Conservation Genetics Workshop on Imperiled Freshwater Mollusks and Fishes

The Freshwater Mollusk Conservation Society and the U.S. Fish and Wildlife Service are sponsoring a workshop on June 29-30, 2004 at the National Conservation Training Center in Shepherdstown, West Virginia. The workshop will provide resource managers and biologists with an opportunity to learn the principles of conservation genetics as applied to recovery of freshwater mollusks and fishes. Nationally recognized experts will introduce the topics of quantitative genetics, molecular genetics, phylogeography, species concepts, taxonomic analysis, detecting cryptic species, hybridization, and genetic management guidelines for captive propagation and stocking of endangered species. Case studies will be presented to demonstrate how the tools of conservation genetics are applied in real-world examples to help protect species. A final discussion will give attendees the opportunity to question the presenters and clarify the implications of concepts learned throughout the program. The registration form can be found at the website of the Freshwater Mollusk Conservation Society (http://ellipse.inhs.uiuc.edu/FMCS/index.html); or contact Dr. Richard Neves, Workshop Coordinator, at (540) 231-5927 or mussel@vt.edu. Meeting registration includes materials, lunches, and breaks. Participants interested in having a poster presentation at the workshop should submit an applicable title and abstract to Dr. Neves before March 31, 2004.

The Virginia Natural History Society
Application for Membership

Name ________________________________

Address________________________________

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Zip Code ________________________________

Phone ________________________________

Area of Interest ________________________

Email ________________________________

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- ☐ $500.00 Life (not annual)
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